STI

UNITED STATES ATOMIC ENERGY COMMISSION

TID-363

RADIUM

A Bibliography of Unclassified Literature

July 1950

Technical Information Division, ORE, Oak Ridge, Tennessee
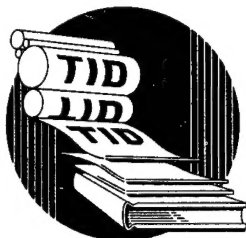
Radium

compiled by

Simone B. Schwind and Fred E. Croxton

ABSTRACT

This bibliography, which is arranged chronologically, consists of 745 references covering the period 1898 to 1950. Indexes to authors, subjects, patent numbers and report numbers are included. Subject coverage does not include the properties of radium emanation and radiation.

INTRODUCTION

This bibliography, which covers the period from the discovery of radium (1898) to 1950, has been compiled from references obtained by searching a number of indexes, abstract journals, and topical reviews. The compilers have leaned heavily upon the abstracts found in Chemical Abstracts, Science Abstracts A, and Nuclear Science Abstracts for annotations.

The two outstanding inorganic source books, Gmelin's Handbuch and Mellor's multivolume work, were used as supplementary sources of references. These are the standard, authoritative sources for the chemistry and physics of radium.

The references in this bibliography have been arranged, as nearly as possible, by the year of publication and are further arranged alphabetically by senior author within that year. It should be remembered, particularly for recent research and papers which were at one time classified, that there is a considerable time-lag between the completion of research and publication of results. Some of the very old references contain just journal citations without article titles. These represent references taken from secondary sources which were not checked against the original articles.

A comprehensive coverage of the research on radium has been attempted, but it is emphasized that this coverage is on radium and its properties and not on the properties and effects of radium radiations and emanations. For example, the decay constants and toxicity of radium are included; however, the properties of the "active deposit" of radium and the use of radium needles in therapy have been excluded, as are the effects of radium radiations on fungi. Since the majority of these references were entered without physical comparison with the original article, some inappropriate references undoubtedly have been included. The responsibility for such errors of inclusion, or omission must be borne by the compilers.

Indexes to authors, subjects, patent numbers, and to report numbers follow the list of references. Index references are made to the sequential numbers which have been assigned to each item listed.

1898

1   Curie, M., Curie, P. and Bémont, G. "Another New Radio-active Element." Compt. rend. 127, 1215-17(1898).

In addition to the new element polonium an entirely different element has been found in small traces in pitchblende residues, in company with barium and analytically behaving as such, but extremely radioactive. By fractional precipitation of the chloride of barium from solution by means of alcohol, chlorides have been obtained containing chlorides of the new element ("radium") which have 900 times the radiant activity of metallic uranium. M. Demarcay has examined the spectrum and finds a notable line at $\lambda = 3814.8$ (Rowland scale) not otherwise identifiable. The trace must be small, for the atomic weight of the barium is only very slightly altered, though it is always altered in one direction, that of increase as compared with inactive barium. The chloride of "radium" makes a photographic negative in half a minute where uranium or thorium or their compounds would take hours; and, through aluminum, it can render a film of platinocyanide of barium permanently luminous sufficiently to make it visible in the dark without any apparent supply of energy. Uranium and thorium do not produce this latter effect, probably because their action is too feeble.

1899

2   de Haën, E. "New Radio-Active Substance." Ann. Physik (Wied.) 68, 902(1899).

By extraction from a large quantity of uranium ore, the author has obtained substances which possess the properties ascribed by M. and Mme. Curie to "radium". Two preparations have been made. Preparation A exhibits the properties of Becquerel rays. It excites fluorescence in a barium platinocyanide screen even across opaque substances, affects the photographic plate, makes air electrically conducting, and has an additional property not hitherto described, that of being itself strongly luminous. Preparation B possesses in general the same properties as preparation A, but the excitement of the screen is more intense, whereas the self-luminosity is feebler. In both cases the rays which produce fluorescence penetrate bodies like black cardboard more readily than they penetrate glass. Both preparations must be carefully preserved from moisture, especially the first preparation, which loses its own luminosity in a few hours when exposed to the moisture of the atmosphere. Once the luminosity is lost it is difficult to restore it. The only expedient which succeeds as a rule is that of melting the substance in the oxyhydrogen blowpipe.

3   Demarcay, E. "Spectrum of Radium." Compt. rend. 129, 716-17(1899).

An account of the photographic spectrum of radium obtained from specimens of barium chloride containing radium. The wave-lengths of fifteen of the strongest of the new rays are given; many of them are as strong as the strongest of those of barium. All the lines are narrow and sharply defined, and resemble those of barium.

4   Giesel, F. Physik. Z. 1, 16-17(1899).

The author reports that the crystals of $RaCl_2 \cdot 2H_2O$ are white at first and become yellowish with time. Information is also included on radium iodide.

1899

5   Giesel, F. Ann. Physik (Wied.) 69, 92(1899). Article includes information on radiumiodide.

6   Meyer, S. Ann. Physik (Wied.) 69, 237(1899). Observations on the magnetic susceptibility of Ra are described.

1900

7   Becquerel, H. "Radium Radiations." Bull. soc. franc. phys. 148, 4(1900).

Radium radiations are of three kinds - a part deviable by a magnetic field; a part non-deviable and readily absorbed; and a part weaker and diffused, non-deviable, attributable partly to secondary rays.

8   Becquerel, H. "Radiations from Radium." Compt. rend. 130, 809-15(1900)

M. and Mme. Curie have shown that the radiations from radium carry negative electric charges. They therefore, like cathode rays, probably depend on the transport of matter. Measurements of the electrostatic deviation in a magnetic field are difficult; details are given. From the results of these measurements, with calculations of the trajectories, it appears that the velocity $v = 1.6 \times 10^{-10}$, and the mass charge ratio for the molecules, $m/e, = 10^{-7}$, quantities of the same order as in the case of cathode rays. And on taking into account M. and Mme. Curie's value for the rate of loss of charge, it follows that the energy radiated/$cm.^2$ is about 5 ergs/sec. and the quantity of matter lost/$cm.^2$ is about one milligram in a milliard years.

9   Berndt, G. "Spectra of Radium and Polonium." Physik. Z. 2, 180-1(1900).

The author first employed active barium chloride (activity 240) and active barium bromide, using a platinum spiral heated electrically, so that very small quantities might be used, and examined the spectra for the radium lines. Of these he found only $\lambda = 3814.591$ of intensity 2, when the intensities are reckoned from 6 to 1 so that 6 indicates the greatest intensity. On using another specimen of active barium chloride (activity 1000) he obtained $\lambda = 4682.346$, Int. 1; $\lambda = 3814.591$, Int. 4; and a new line $\lambda = 2708.6$, Int. 1. Up to $\lambda = 2100$ no more radium lines were found.

10   Curie, M. and Curie, P. "Radio-active Bodies." Bull. soc. franç. phys. 142, 6(1900).

Polonium (which chemically resembles bismuth) falls off slowly in its radioactive power. Radium (similar to barium) seems to have a higher atomic weight than barium, for the atomic weight of barium seems higher (146) in radiferous barium compounds than it does (137) in compounds free from radium. The solid compounds of radium become more radioactive as time goes on, and do not reach their maximum activity within a month; their initial condition is restored by dissolving them and recrystallizing. The chloride and bromide of radium are the most brightly luminous compounds; but all the salts are so to some extent. Induced phosphorescence and induced radioactivity in the neighborhood of radium as described by Becquerel were discovered by the authors.

1900

11   Curie, P. and Curie, M. "New Radio-active Substances." Report Intern. Phys. Congress Paris 3, 79-114(1900).

A method of measuring radioactivity by means of an electrometer is described, and a list of uranium compounds and their activities is added. The report deals also with thorium, polonium, and radium, the spectrum and atomic weight of the latter, and the penetrating power and activity-inducing power of the rays.

12   Demarcay, E. "Spectrum of Radium." Compt. rend. 131, 258-9(1900).

A specimen of very pure radium, with barium lines very feeble, gave no lines beyond those already found, but some weak nebulous rays are much better marked. The spectrographic characters of radium are similar to those of the alkaline earths.

13   Miethe, A. Physik. Z. 2, 267(1900).

A description of the spark spectrum of Ra is given.

14   Runge, C. "Spectrum of Radium." Ann. Physik (4), 2, 742-5(1900).

The author criticizes the fifteen spectrum lines ascribed by Demarcay to radium. He points out that the accuracy with which these fifteen lines were determined is not very great, the error being about 0.7 of an Ångström unit. Hence Demarcay's line 4683.0 might be anywhere between 4682.3 and 4683.7. But in this interval there are no less than six Fraunhofer lines, according to Rowland, and that makes the evidence for the separate identity of radium much feebler than it was. The author has therefore redetermined the spectrum of radioactive barium chloride with a greater dispersive power than that employed by Demarcay, and has definitely located three of Demarcay's lines. These are situated at 4826.14, 4682.346, and 3814.591 respectively. The remainder were either invisible or were found in the spectrum of barium chloride when free from radium. An economical method of obtaining the spectrum was that of dipping a thin platinum wire into the powdered preparation and heating the wire by means of an electric current until a bead was formed, which was then made an anode in a spark-gap. But it is possible that the luminous intensity attained was not great enough to reveal some of the feebler lines described by Demarcay. But the three lines mentioned are definitely established, and they are not contained in the solar spectrum.

1901

15   Berthelot, M. P. E. "Chemical Action of Radium." Compt. rend. 133, 973-6(1901).

Experiments were made to determine whether radium exerted any decomposing action on iodine pentoxide, this reaction being chosen on account of its endothermic character. The radioactive material had a mass of 0.145 g., about one-eighth of this being chloride of radium, and the remainder chloride of barium. It was placed in a very small sealed glass tube which was surrounded by a thin, somewhat wider, tube, around which was placed 4 to 5 g. of white iodine pentoxide, any volatile products of decomposition

1901

being carried off by a current of dry air. The decomposition of the iodine pentoxide was noticed only under the influence of radium, and when the tube containing it was not surrounded by black paper, that is, under the conditions in which the phosphorescence of the mixture manifests itself. The radiations which produce this phosphorescence in consequence of a double transformation of energy played a characteristic part in the actual experiment. Series of experiments were carried out at 10° and at 100°. According to Curie and Becquerel, the energy radiated by a layer of radioactive matter of 2 mm. thickness spread over 1 cm.^{2} of surface is about 5 c.g.s. units of energy/sec. Calculating from these numbers the amount of iodine set free by the endothermic decomposition of I_2O_5 in the experiment described would amount to not more than $^1/_{200}$ of a milligram. This value corresponds to the order of magnitude of the phenomena observed by the author.

16   Curie, M. and Debierne, A. Compt. rend. 132, 768 (1901).

Some properties of metallic Ra are given.

17   Exner, F. and Haschek, E. Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 110, 2a, 964(1901).

The spark spectrum of Ra is described.

1902

18   Curie, M. "Atomic Weight of Radium." Compt. rend. 135, 161-3(1902).

By fractional crystallization of a large quantity of radiferous barium chloride a decigram of radium chloride was obtained of such purity as to show in the spectroscope only faint lines of barium. Three determinations of the silver chloride obtained by precipitation with silver nitrate gave a mean atomic weight of 225, which is considered correct within one unit. When certain quantities of Ba and Ra are present, the crystals have a yellow or rose color. Radium chloride itself is colorless and spontaneously luminous. The element by its chemical properties belongs to the alkaline-earth series, and in the periodic system takes its place between Ba and Th and U.

19   Giesel, F. "Radium and Radio-active Substances." Chem. News 86, 250-1(1902).

Observations on the chemical behavior and radio-active properties of various salts of Ra, Po, and other radio-active elements.

20   Giesel, F. "Radium." Physik. Z. 3, 578-9(1902).

The preparation of radium chloride is described: when approaching purity it gives a carmine red flame instead of the green of barium. The spectrum has two bright lines in the red, one bright line in the blue, and two fainter ones in the violet. The spark spectrum is probably not the same as the flame spectrum.

21   Rutherford, E. and Soddy, F. Phil. Mag. (6), 4, 374(1902).

The authors report the half-life period of Ra^{224} to be about 4 days.

1903

22   Becquerel, H. "Magnetic Deviability of Certain Rays sent out by Radium." Compt. rend. 136, 199-203(1903).

The radio-active substance was placed in a groove hollowed out in a block of lead. Above this, at a height of about 1 cm., was arranged a metallic screen with a slit in it parallel to the groove, and above this again a photographic plate. The whole was put in the field of an electromagnet, the slit being parallel to the field. When the magnetic field was excited first in one sense and then in the other, two images of the beam were obtained on the proof, which shows that the pencil of rays was deviated first in one direction and then in the other. In one case, a distance between the images of 1 mm. was obtained. Further experiments showed that the direction of the deviation agreed with the results obtained by Rutherford.

23   Becquerel, H. "Radiation from Polonium and Radium." Compt. rend. 136, 431-4(1903).

Proofs have been obtained that the α-rays from Ra and the radiation from Po are identical. It was previously pointed out that the degrees of absorption of the two kinds of rays were analogous. They are shown to behave similarly as regards deviability. A photographic method of experiment was adopted, the two proofs - the feeble one of polonium and the intense one of radium - appeared superimposable. The direction of the deviation of both kinds of radiation was the inverse of that of cathode rays. The different kinds of radiation emitted by active bodies may be thus classed: (1) Uranium emits only radiations charged with negative electricity and very penetrating. (2) Polonium emits only rays charged with positive electricity and very penetrating. (3) Thorium and radium emit both these kinds of radiation. Radium sends out besides these, very penetrating non-deviable rays. The nature of these is unknown, but they exhibit various characteristics which are also found in the case of Roentgen rays.

24   Crookes, W. Chem. News 88, 202(1903).
The ultra-violet spectrum of Ra is described.

25   Crookes, W. "Ultra-violet Spectrum of Radium." Proc. Roy. Soc. (London) 72A, 295-304(1903).

The spark spectrum of a solution of radium nitrate was photographed with the iron spark spectrum in juxtaposition as standard. Self-induction was used in order to eliminate the air lines. Details of the 5 quartz-prism spectrograph and the methods of measurement and calculation are given in the paper. A reproduction of the radium spectrum is also appended.

26   Curie, M. "Atomic Weight of Radium." Physik. Z. 4, 456-7(1903).

The author points out that the value 258, which was given by Runge and Precht for the atomic weight of radium on the basis of an experimental law dealing with the distribution of lines in the spectra of the neighboring elements, Ca, Sr, and Ba, is arrived at by extrapolation, and is probably not the true number. The suggestion of Runge and Precht that the radium which was examined by the author, and which gave the atomic weight 224, contained barium is untenable, as it was shown to be spectrally pure.

1903

27   Curie, P., and Cheneveau, C. Bull. soc phys. 1, (1903).

The authors found the magnetic susceptibility of $RaCl_2$ to be $+ 1.05 \times 10^{-6}$, so that the element is feebly paramagnetic in combination. Ba is diamagnetic, -0.40×10^{-6}; hence, observations on samples contaminated with Ba are very unreliable.

28   Curie, P. and Laborde, A. "Heat Set Free Spontaneously by Salts of Radium." Compt. rend. 136, 673-5(1903).

It has been proved that the salts of radium disengage heat in a continuous manner. A thermo-couple, iron-constantan, of which one junction was surrounded by radiferous barium chloride, and the other by pure barium chloride, shows a difference of temperature between the two substances. The radiferous salt was found to have a temperature 1.5° higher than the other. On performing a control experiment with two specimens of pure barium chloride, the differences of temperature observed were only of the order of magnitude of 1/100°. It was sought to measure quantitatively the heat disengaged in a given time by the radium. (1) The heat set free was compared with that produced by the passage of a known current through a known resistance. (2) The heat disengaged by radium was measured by direct observations with Bunsen's calorimeter. One gram of radiferous barium chloride which was used in the experiments, set free about 14 cal. per hour. The composition of the product used was not exactly known. According to its radiant activity it ought to have contained about 1/6 of its weight of pure barium chloride. Measurements were also made with a sample of 0.08 g. of pure radium chloride. These led to results of the same order of magnitude as before. One gram of radium disengages a quantity of heat which is of the order of 100 cal. per hour. One gram-atom of radium (225 g.) would set free each hour 22,500 cal., an amount comparable with that produced by the combustion in oxygen of 1 gram-atom of hydrogen.

29   Debierne, A. Chem. News 88, 136(1903).
The separation of radium salts by fractional crystallization is described.

30   Dorn, E. "Noteworthy Observation with Radium." Physik. Z. 4, 507-08(1903).

On Dec. 3, 1902, 30 mg. of the strongest radium bromide available were sealed up in a tube of alkali-free Jena glass for the purpose of determining the supposed loss of weight by radium salts. On May 27, 1903, six months later, it was desired to open the tube, and for this purpose a triangular file was used. Immediately the file touched the surface of the tube, the glass was pierced by an electric spark which was clearly visible in broad daylight immediately in front of the window. The sound was so loud that an assistant who in the room at the time mistook it for the discharge of a small induction coil. It is suggested that the escape of the negatively charged β-particles and the retention by the glass of the positively charged α-particles had produced a strong positive charge on the inside of the glass, and that ultimately the potential difference (which must have amounted to some thousands of volts) had proved sufficient to pierce through 0.3 mm. of glass.

1903

31   Giesel, F. "Radium." Ber. 36, 342-7(1903).
A solution of 1 g. of "5 per cent" radium bromide liber-
ated in 16 days 3.5 cc. of gas containing 78% hydrogen and
17% oxygen, while the solution became colored with bromine.
Radium thus sets up a kind of electrolysis, the cation being
hydrogen and the anion hydroxyl or bromine. It is calculated
that the 5 cg. of radium bromide generate (or transform) in
this way energy to the extent of 1.8 watts -secs. =0.42 cal.
=18,000 g. cm. per day.

32   Huggins, W. and Huggins, Lady. "Spectrum of the
        Spontaneous Luminous Radiation of Radium at Or-
        dinary Temperatures." Proc. Roy. Soc. (London)
        72A, 196-9(1903).
A photograph of this spectrum showed no lines due to ra-
dium, but eight other lines which were so close to the bands
in the nitrogen spectrum as to justify the conclusion that
they were due to this gas.

33   Precht, J. Sitzber. k. preuss. Akad. Wiss. Berlin
        783(1903)
The author reports that 1g. of Ra generates about 113 cal./
hour.

34   Ramsay, W. and Soddy, F. "Gases Occluded by Ra-
        dium Bromide." Nature 68, 246(1903).
The gases evolved from 20 mg of radium bromide, which
had been kept for a long time in the solid state, were exam-
ined. After the hydrogen and oxygen were removed the spec-
troscope showed the presence of carbon dioxide. After freez-
ing out this gas together with the emanation, the residue
gave the D_3 line of helium. This was repeated with a further
quantity of the radium salt, when the spectrum was found to
be that of pure helium with two new lines. From Rutherford's
work upon the mass of the "α-rays," the authors consider
that their results prove that these "rays" consist of helium.

35   Ramsay, W. and Soddy, F. "Production of Helium
        from Radium." Proc. Roy. Soc. (London) 72A,
        204-07(1903).
The maximum amount of the emanation obtained from 50
mg. of radium bromide was conveyed by means of oxygen
into a U-tube cooled in liquid air, and the oxygen was then
extracted by the pump. It was then washed out with a little
fresh oxygen, which was again pumped off. The vacuum tube
sealed on to the U-tube, after removing the liquid air showed
no trace of helium. The spectrum was apparently a new one,
probably that of the emanation. After standing four days the
helium spectrum appeared, and the characteristic lines were
observed identical in position with those of a helium tube
thrown into the field of vision at the same time. On the fifth
day the yellow, the green, the two blues, and the violet were
seen, and in addition the three new lines also present in the
helium obtained from radium. A confirmatory experiment
gave identical results.

36   Runge, C. and Precht, J. "Flame Spectrum of Ra-
        dium." Ann. Physik. (Wied.) (4), 10, 655-7(1903).
A piece of platinum wire with a looped end was heated to
redness by an electric current, and a small fragment of ra-
dium bromide was brought against it. The salt adhered to
the wire and melted, so that a bead was formed with phos-

phoresced brightly on cooling. When this bead was brought
into a Bunsen flame a red coloration was produced, the lines
of whose spectrum were visually measured. The wave-lengths
of these lines are given in the paper; the most important
lines occur at λ = 6653, 6349, and 4826. Three bands also occur
in the red, two of which are very strong, namely, those from
λ = 6700 to λ = 6530, and from λ = 6330 to λ = 6130; these
very possibly belong to the spectrum of the compound radium
bromide.

37   Runge, C. and Precht. J. "Spark Spectrum of Ra-
        dium." Ann. Physik (Wied.) (4), 12, 407-12(1903).
A table is given of the wave-lengths of 40 lines in the
spark spectrum of radium bromide, taken by an induction
coil on platinum poles, and photographed with a large con-
cave Rowland grating. Comparisons with the values given
by Demarcay and Exner and Haschek are indicated.

38   Runge, C. and Precht, J. "Position of Radium in
        the Periodic System as Determined by its Spectrum."
        Physik. Z. 4, 285-7(1903).
By means of their behavior in the magnetic field the
authors selected the lines in the radium spectrum which
form the first pair in the principal and the first and second
subordinate series respectively. These lines correspond ex-
actly to the similar lines in the spectra of magnesium, cal-
cium, strontium, and barium. It is well known that the fre-
quency differences of all the pairs of the two subordinate
series and the first pair of the principal series are all equal.
This frequency difference is nearly proportional to the
square root of the atomic weight for the elements of one
chemical family. This is not strictly true, and the authors
state the law as follows: The atomic weight is proportional
to a power of the frequency difference, or the logarithms of
the atomic weights are a linear function of the logarithms
of the frequency differences. These frequency differences
for magnesium, calcium, strontium, and barium are 91.7,
223, 801 and 1691; on plotting the logarithms of these num-
bers against the logarithms of the atomic weights a straight
line is drawn through the points and is extrapolated to find
the atomic weight of radium, taking its frequency difference
as 4858.5. In this way the atomic weight is found to be 257.8.
This value does not deserve more consideration than that
experimentally determined by M. Curie as 225, but it must
be remembered that barium and radium bromides are iso-
morphous, and therefore very difficult to separate. An in-
complete separation would tend to lower the atomic weights
as determined by chemical means. The value 225, on the
other hand, fits in with the periodic system much better than
257.8.

39   Runge, C. and Precht, J. "Heat Production of Ra-
        dium." Sitzber k. preuss. Akad. Wiss. Berlin
        38, 783-6(1903).
The authors have compared the output of heat of 57 mg. of
radium bromide with that produced in a platinum spiral by
the passage of an electric current. The heat produced was
found to be 65 cals. per hour for 1 g. of radium bromide:
or if 257 is assumed as the atomic weight of radium, the
heat produced by 1 g. of radium is 105 cal./hour. This
agrees with Curies' and Laborde's result, which gave the
output of energy as of the order of 100 cals. per hour.

1903

40   Strutt, R. J. "The γ-rays of Radium." Proc. Roy. Soc. (London) 72A; 208-10(1903).

Measurements of the rate of leak produced in various gases by the γ-rays from radium are given, and a table of the relative ionizations produced by the three varieties of radium-rays and by Roentgen-rays. The values of these latter for the γ-rays are about the same as those for the β-rays.

41   Townsend, J. S. "Ionization Produced by Radium Corpuscles." Phil. Mag. (6), 5, 698-9(1903).

From experiments previously described the author concluded that each of the corpuscles given out by radium generates at least 13 ions per cm. in air at 1 mm. pressure. Durack in his observations found the number 0.4. It is here suggested that the difference in the values is due to the differing thickness of the aluminum through which the radium corpuscles had to pass before reaching the gas. The thickness was greater in the author's experiments, so that the corpuscles passing through the gas would be travelling with diminished velocity and consequently would each produce a larger number of ions per cm. in the gas.

42   Watts, W. M. "Atomic Weight of Radium." Phil. Mag. (6), 6, 64-6(1903).

The author has previously shown that there appear to be two distinct kinds of connection between the spectra of allied elements and their atomic weights. In the case of zinc, cadmium, and mercury, and of gallium and iridium, the differences between the oscillation-frequencies of certain lines of the one element are to the differences between the oscillation frequencies of the other element as the squares of their atomic weights. In applying this method some uncertainty exists as to the correspondence of the lines in the different spectra, but it is possible by accumulating evidence of this kind to obtain indications as to the probable atomic weight of radium from a comparison of its spectrum with those of mercury, barium, and calcium. By selecting appropriate lines it is possible to deduce for the atomic weight of radium the values 226.32, 226.42, 225.21, 225.32, 226.52, from the first type of relationship, and the values 225.05, 223.47, 220.36, 223.13, 227.39, and 224.63 from the second type of relationship. The mean of all these results is 224.89, the experimental value being 225. While the spectroscopic evidence now adduced is not of a very certain character, it serves to throw doubt upon the calculations by which Runge and Precht deduced the value 258 for the atomic weight of radium, and indicates that the analytical value is not incapable of being reconciled with the spectroscopic evidence.

43   Wien, W. "Radium Radiation." Physik. Z. 4, 624-6(1903).

Observations were made based upon the self-electrification of radium. The two kinds of radiation appeared to be sent out in not too different amounts considering the quantity of electricity. Taking Des Coudres' observations on the ratio m/e, viz., 1.6×10^{-4} for the positive particles and 1×10^7 for the negative, m = 2.5×10^{-20} g. per sec. for the negative and 4.6×10^{-17} for the positive. Hence the energy of the radiation is not inconsiderable. Taking v = 2.5×10^{10} for the negative and 1.65×10^9 for the positive, for the first $1/2mv$ = 8.7 ergs and for the others $1/2mv^2$ = 60 ergs per sec.

1904

44   Ångström, K. "Heat Given Out by Radium." Arkiv. Mat. Astron. Fysik 1, 523-8(1904).

Using 100 mg of specially pure radium bromide, the author found that 1 gm. of radium bromide gives out 1.14 cals. per min. or 68.5 cal. per hour, so that 1 g. of pure radium would give (taking the atomic weight of radium as 225) 117 cal. per hour (or 110 cal. for atomic weight 258). These values are somewhat higher than those obtained by Precht. In 7 months the radium gave off altogether 345,000 cal. per g.

45   Coehn, A. "Electrochemical Behavior of Radium" Ber. 37, 811-16(1904).

From the thermochemical data it would appear that the separation of the metal would be increasingly difficult in the series Ca, Sr, Ba, but when a mercury cathode is used the voltage required is greatly reduced owing to the energy liberated in the formation of an amalgam, and the order in which the metals separate is reversed. Thus it requires 0.2 volt more to separate strontium from barium, and 0.25 volt more to separate calcium than strontium; if the series were continued, radium should require less voltage than barium by considerably more than 0.25 volt, and it is actually found that metallic radium is precipitated by barium amalgam. Owing to the very small proportion of radium in the crude bromide it is impossible to effect a sharp separation of the metals except at an impracticably small current-density, but a considerable concentration may be effected by this method. It is of interest to note that freshly prepared (unoxidized) radium amalgam, like the salts of the metal, only slowly attains its maximum activity, while the (silver) anode, which appears to attract to itself the greater part of the excited activity and is at first more radio-active than the cathode, soon becomes altogether inactive.

46   Dewar, S., Curie, M. and Curie, P. "Examination of the Gas Occluded or Set Free by Radium Bromide." Compt. rend. 138, 190-92(1904).

A spectroscopic examination of the gas pumped off from radium bromide showed that it contained helium.

47   Joly, J. "Behavior of Radium Bromide at High Temperatures." Nature 70, 31(1904).

From observations on minute specks of radium bromide heated upon the platinum ribbon of the meldometer its melting-point is found to be 728°C. At higher temperatures —up to 1,600°-there is every appearance of decomposition, a quiescent glass finally remaining on the hot platinum. This is insoluble in hot or cold water or HCl.

48   Marckwald, W. Ann. Physik (Wied.) 37, 88(1904).

A method for extracting radium by converting the sulfates to chlorides is described.

49   Marckwald, W. "Separation of Radium." Ber. 37, 88(1904).

A method for obtaining a radium amalgam from a concentrated solution of Ra-Ba chloride by repeated shaking with a sodium amalgam is described.

50   Marckwald, W. "Separation of Radium." Chem. News 89, 97-8(1904).

A method of separating radium chloride from barium chloride is described. If a concentrated solution of radium bar-

1904

ium chloride is shaken up with a fifth of its weight of sodium amalgam, a radium and barium amalgam is formed, and the proportion of radium to barium in the amalgam is very much higher than in the solution. By repeating the process many times the radium can be accumulated.

51   Matout, L. "The Radiation from Radium." Radium, Le 1, 6-14(1904).

A general paper dealing with the examination of the different actions of the radiation by (1) phosphorescence methods, and (2) the magnetic field. An experimental arrangement of Becquerel's, comprising two concentric cylindrical lead screens provided with small openings at different places, the radium, being in the interior of the inner screen, is recommended as a convenient photographic method of studying the absorptive power of a screen for rays of a definite velocity. Illustrations are given showing the results obtained.

52   Paschen. F. "Penetrating Rays of Radium." Ann. Physik. (Wied.) (4), 14, 164-71(1904).

A quantity of radium bromide, enclosed in a glass tube with walls 0.8 mm. thick, was insulated in a vacuum by a quartz suspension and found to gain in potential at the rate of 132.5 v./min. owing to the escape of the negatively-charged β-rays. The radium salt was then enclosed in a sheath of lead 1 cm. thick, and the change of potential was again determined. The absorption coefficient of the β-rays by lead is 62.5 and the absorption by 1 cm. should reduce the amount of radiation to $e^{-62.5}$ or 10^{-27} of that originally transmitted. The actual increase of potential, was, however, only reduced in the ratio 1:85, and this residual effect the author attributes to the γ-rays, which he therefore regards as negatively charged. The following table shows the way in which the coefficient of absorption varies with the thickness of lead through which the radiation has travelled. The absorption coefficient for the β-rays as determined by Strutt is 62.5, while the most penetrating rays in the case described above have a coefficient only one-fiftieth as great.

Thickness of lead, d....	0	0.0264	0.0528	0.48	1.32	1.92 cm
Capacity.....................	1.93	3.172	3.57	3.31	4.655	5.87×10^{-12} Farad
Rise of potential $\frac{dV}{dt}$	132.5	16.48	8.02	2.86	0.672	0.249 volt/minute
Current.....................	462.3	87.16	47.7	15.8	5.21	2.435×10^{-14} amp
Absorption coefficient α	60.13	22.82	2.593	1.32	1.27	

53   Paschen, F. Physik. Z. 5, 563(1904).

The author reports that 1 g. of Ra generates about 126 cal./hour.

54   Precht, J. Jahrb. Radioakt. u. Elektsonik 1, 61(1904)

The spark spectrum of Ra is described.

55   Precht. J. "Heat Production of Radium." Verhandl. deut. physik. Ges. (2), 6, 101-03(1904).

The author measured, by means of an ice calorimeter, the heat given out by 34.1 mg. of radium bromide. The mean value was 2.085 cal./hour. Thus 1 g. of radium bromide produces 61.15 cal./hour, and taking $RaBr_2$ as the formula, and assuming the atomic weight of radium obtained from spectroscopic observations, viz., 258, the output of heat of 1 g. of Ra per hour would be 98.83 cal. The number is 113.3 cal. if M. Curie's number for the atomic weight of radium (225) is taken. The number obtained agrees well with earlier observations.

1904

56   Ramsay, W. and Soddy, F. "Production of Helium from Radium." Physik. Z. 5, 349-56(1904).

The paper describes the continuation of the research undertaken with the object of ascertaining the volume of emanation produced in a given time from a given weight of radium bromide, and also the quantity of helium resulting. The values found are extremely small, and the determinations involved repeated separations from minute quantities of nitrogen occurring as impurities. It was concluded that 1 g. of radium produced 3×10^{-6}mm³. of Rn/sec.

57   Ramsay, W. and Soddy, F. "Production of Helium from Radium." Proc. Roy Soc. (London) 73A, 346-58(1904).

The paper describes the continuation of the research undertaken with the object of ascertaining the volume of emanation produced in a given time from a given weight of radium bromide, and also the quantity of helium resulting. The values found are extremely small, and the determinations involved repeated separations from minute quantities of nitrogen occurring as impurities. It was concluded that 1 g. of radium produced 3×10^{-6} mm.³ of Rn/sec.

58   Ramsay, W. and Soddy, F. "Production of Helium from Radium." Z. physik. Chem. 48, 682-96(1904).

The paper describes the continuation of the research undertaken with the object of ascertaining the volume of emanation produced in a given time from a given weight of radium bromide, and also the quantity of helium resulting. The values found are extremely small, and the determinations involved repeated separations from minute quantities of nitrogen occurring as impurities. It was concluded that 1 g. of radium produced 3×10^{-6} mm³. of Rn/sec. This article contains the same information as the preceding reference.

59   Runge, C. and Precht. J. "Spark Spectrum of Radium." Ann. Physik. (Wied.) (4) 14, 418-22(1904).

The authors give a number of new lines in the spark spectrum of radium, for which a more highly purified sample of radium bromide was employed than that used in their previous measurements.

60   Runge, C. and Precht, J. "Magnetic Analysis of Radium Spectrum." Sitzber. k. preuss. Akad. Wiss. Berlin 10, 417-25(1904).

Several of the chief lines in the radium spectrum have been examined under the action of a strong magnetic field, and the results analyzed in connection with similar determinations on the spectrum lines of the elements Mg, Ca, Sr, Ba, the intensity of field being about 30,000 c.g.s. A plate is given from a photograph of the line 5814, showing the six components clearly. Logarithmic curves show an intimate relation in the behavior of the radium spectrum and those of the above elements.

61   Rutherford, E. "Radio-activity of Radium and its Concentration." Nature 69, 222(1904).

The question whether the radio-activity of radium depended upon its concentration was tested by measuring the radio-activity of radium bromide (1) when in the solid state and (2) when diffused throughout a solution more than a thousand times the volume of the solid. It was found that in the sec-

1904

ond case no appreciable influence on the radioactivity of the compound was exerted. The radio-activity of radium over the range investigated is not affected by its own intense radiations. It is thus improbable that the energy given out by radium is due to absorption of an unknown external radiation which is similar in character to the radiations which are emitted.

62   Rutherford, E. and Barnes, H. T. "Heating Effect of the Radium Emanation." Phil. Mag. (6), 7, 202-19(1904).

(Paper read before the American Physical Society, St. Louis, Dec. 29, 1903). Experiments were undertaken to determine how the heat of emission of radium is connected with its radio-activity. The heating effect of 30 mg. of pure radium bromide was first measured in a differential air calorimeter. The radium bromide was then heated to a sufficient temperature to drive off the Rn and the latter was condensed by passing through a short glass tube immersed in liquid air, and then the tubes were sealed off. On testing the de-emanated radium the heating effect diminished rapidly during the first few hours, falling to a minimum corresponding to about 30% of the original value, and then slowly increased again. On substituting the emanation tube in the calorimeter, the heating effect at first increased, for a few hours, to a maximum corresponding to about 70% of the original heat emission of the radium, and then slowly decayed with time. The sum-total of the heating effect of the radium together with that of the emanation tube was found to be equal to that of the original radium. About 6% of the emanation in one experiment appeared not to be released from the radium by the heating. About 75% of the heating effect observed from radium is not directly due to the radium but to the emanation and induced activity. There is a close connection between the variation of the radio-activity of the radium and its rate of heat emission. After separation of the emanation, the activity of the radium falls to a minimum of about 25% in the course of a few hours and then gradually increases again. At the same time, the activity due to the emanation increases with time, on account of the excited activity produced by the emanation on the walls of the vessel. The curves of recovery of the heating effect of radium and the gradual decrease of the heating effect of the emanation are almost exactly the same as the corresponding curves for the recovery of activity of the radium and the loss of activity with time of the separated emanation. The heating effect of radium appears to be proportional to its activity measured by the α-rays; or the heat emission seems to be an accompaniment of the expulsion of α particles. There is a very sudden drop of the heating effect, observed for both the emanation tube and the radium, after removal of the emanation. The activity drops to 82% of the maximum value. Thus the radiation supplies about 18% of the total activity of radium measured by the α-rays. There then follows a fairly rapid decrease for 6 to 8 min., and then a more gradual decay to a minimum of 25%. The other results indicate that the heating effects accompany the emission of α-rays. The heating effect from the emanation together with that of the active product to which it gives rise is equal to about 75% of the total heat emission of radium. Since 1 g. of radium emits heat at a rate of 100 g. cal./hour; the emanation from 1 g. of radium a few hours after its removal radiates heat at the rate of 75 g.-cal./hour. It is calculated that the total amount

1904

of heat derived from the emanation from 1 g. of radium is about 10,000 g.-cal. The amount of heat liberated per hour from 1 cc. of the emanation would lie between 1.25×10^5 and 1.25×10^6 g.-cal. This amount from 1 cc. would probably be sufficient to raise to a red heat, if not to melt down, the glass tube containing it. The emanation behaves as if it were a gas of heavy molecular weight, and the authors calculate that 1 lb. of the emanation, while the heating continued, would emit an amount of energy between 6×10^4 and 6×10^5 h.p.-days. On the disintegration hypothesis the large amounts of energy involved are derived from the energy latent in the radium atoms, which is released in the successive stages of the disintegration.

63   Strutt, R. J. "Polonium and Radium." Nature 70, 627(1904).

An account is given of an experiment which tends to show that the polonium found in radio-active minerals is a product of the radium they contain.

64   Sutherland, W. "Atomic Weight of Radium." Nature 69, 606-07(1904).

Runge and Precht work out the atomic weight of radium from its spectrum to be 258 instead of 225 found by M. Curie. The author of this note discusses the numerical relationships shown in spectra, and points out that the spectral data of radium support the value of the atomic weight given by M. Curie, if handled according to the method previously described by him.

65   Thomson, J. J. "Relation between Mass and Weight for Radium." Trans. Intern. Elect. Congress 1, 234-41(1904).

66   Voller, A. "Decay of Radio-activity and Life of Radium in the Finely-divided State." Verhandl. deut. physik. Ges. (2) 6, 291-2(1904).

The author has carried out a series of long-continued experiments on the time rate of decay of the radio-activity of radium, and on the life of radium in very small quantities with the object of testing the view of J. J. Thomson that the radiation intensity depends upon its state of subdivision. Pure radium bromide in small quantities (10^{-3} to 10^{-9} mg.) in different thicknesses on glass plates was examined for the ionizing effect on an Elster-Geitel-Ebert electroscope without aspirator. The rates of discharge with and without the radium were examined, care being taken that the emanation produced no effect. As a result it was found that the weakest plates became quite ineffective after 15 days' others after 21, 61, and more days' the stronger ones had diminished in effectiveness after 100 days, but were still radioactive. The life, as a function of the concentration, gives a rapidly rising curve, from which one can see that from 10^{-3} mg. the radio-activity would only cease after years. The life attributed to radium by P. and Mme. Curie, and by Ramsay, Soddy, and others is considered consistent with these results.

67   Wedekind, E. "Electrolytic Enriching of Radium from Radium-Barium Preparations." Chem. Ztg. 28, 269-70(1904).

On radium-barium chloride, freshly prepared from crude radium-barium carbonate, being electrolyzed (mercury cathode and platinum anode), the amalgam formed at the beginning

1904

of the electrolysis was found to be more strongly radio-active than that formed later.

1905

68   Ångström, K. "Heat Given out by Radium." Arkiv. Mat. Astron. Fysik 2, No. 12(1905). (Paper read before the Liegè Congrès de Radiologie.)

Two metal vessels contain, the one a quantity of radium bromide, the other a heating coil. A current is sent through the latter until the steady temperature in each vessel is the same, this equality being shown by a thermocouple. No matter what the vessels are composed of - lead, copper, or aluminum - the amount of heat developed by the radium is the same, viz., 1.136 g. cal./min. for every g. of the radium bromide. The heating effect of the γ-rays is therefore small.

69   Ångström, K. "Heat Given Out by Radium." Physik. Z. 6, 685-8(1905). (Paper read before the Liège Congrès de Radiologie.)

This article is similar to the previous reference.

70   Battelli, A. and F. Maccarrone. "Are Emanations Electrified?" Physik Z. 6, 161-3(1905).

Emanations from radio-active substances ($RaBr_2$, Giesel's material) carry no electrical charges, and are therefore probably neither residues of atoms which have lost positive ions nor are they these positive ions themselves.

71   Bragg, W. H. "The α-particles of Radium." Phil. Mag. (6), 10, 600-02(1905).

A discussion of some of the author's results in the light of more recent knowledge.

If the ionization varies inversely as the nth power of the velocity, n is found nearly equal to 2.

72   Bragg, W. H. and Kleeman, R. "Range of α-particles of Radium." Phil. Mag. (6), 10, 318-40(1905). (Paper read before the Royal Society of S. Australia June 6, 1904.)

The authors have improved the apparatus previously used by them, and have repeated their observations on the range of the α-particles from radium. The fact that there are four sets of these differing only in velocity is clearly established. The substances on which range observations have been made are the following: Gold, platinum, tin, silver, copper, aluminum, air, methyl bromide and iodide, carbon tetrachloride, ether, and hydrogen. Instead of giving numbers showing the stopping powers of strata of different materials of the same weight, they are referred to layers containing the same number of atoms, an imaginary air atom of atomic weight 14.4 being taken as having unit stopping power. The law of absorption as given by the usual exponential equation is considered to be altogether untrue. From a discussion of the results the following conclusions are arrived at: (1) That the α-particle makes the same number of ions during its course, no matter what the gas it traverses; (2) that the energy required to make a pair of ions is always the same; and (3) that the observed variations in the conductivities, in some cases are due to the failure of ions to get free from the molecule in which they are made.

73   Burke, J. B. "Action of Radium on Gelatin." J. Roentgen Soc. 2, 34-40(1905).

1905

74   Eve, A. S. "Infection of Laboratories by Radium." Nature 71, 460-1(1905).

Attempts to make electroscopes having a very small natural leak have been repeatedly unsuccessful in the physics laboratory of the McGill University. It has been found that all the materials in the laboratory have become radio-active owing to the presence of radium emanation. About 90% of the activity can be removed by strong hydrochloric acid. The author recommends that, in laboratories not already infected, any radium should be kept in closed vessels, and none of the emanation discharged except into the outside air.

75   Eve, A. S. "Properties of Radium in Small Quantities." Phil. Mag. (6), 9, 708-12(1905). Appendix by E. Rutherford.

According to Voller the life of radium is considerably shortened if the radium salt which is tested is taken in very small amounts. Thus if the mass is 10^{-4} mg. the life is 126 days, if 10^{-9} mg. the life is reduced to 15 days. This is so opposed to the usual theories of radio-active change that Eve has repeated the experiments. The results entirely negate those of Voller. The activity is always proportional to the quantity of the salt present, and in one case where 10^{-6} mg. was spread over 76 cm². by deposition from solution, more than 40 days passed since the maximum activity was reached, although, according to Voller, the activity should have disappeared entirely in about 20 days. Eve points out that as Voller's experiments were carried out with the radium exposed to the free atmosphere, the decrease in activity is due to the dispersion of the active matter into the surrounding space. In his own investigations the salt is always tested in a closed vessel.

76   Eve, A. S. "Properties of Radium in Small Quantities." Physik. Z. 6, 267-9(1905). Appendix by E. Rutherford.

According to Voller the life of radium is considerably shortened if the radium salt which is tested is taken in very small amounts. Thus if the mass is 10^{-4} mg. the life is 126 days, if 10^{-9} mg. the life is reduced to 15 days. This is so opposed to the usual theories of radio-active change that Eve has repeated the experiments. The results entirely negate those of Voller. The activity is always proportional to the quantity of the salt present, and in one case where 10^{-6} mg. was spread over 76 cm². by deposition from solution, more than 40 days passed since the maximum activity was reached, although, according to Voller, the activity should have disappeared entirely in about 20 days. Eve points out that as Voller's experiments were carried out with the radium exposed to the free atmosphere, the decrease in activity is due to the dispersion of the active matter into the surrounding space. In his own investigations the salt is always tested in a closed vessel.

This article is similar to the previous reference.

77   Godlewsky, T. Phil. Mag. (6), 10, 35-9(1905).

A method for the separation of Ra^{223} (AcX) from Ac preparations by precipitating Ac and Th by ammonia. The Ra^{223} remains in the filtrate. A value of 10.2 days is reported for the Ra^{223} half-life.

78   Hahn, O. Jahrb. Radioakt. u. Elektronik 2, 256 (1905).

1905

The author reports the half-life of ThX (Ra^{224}) to be 4.6 days.

79   Haynes, H. J. and Engle, W. D. (to the Dolores Refining Company) U. S. Pat. 808839 (1905).
A method for leaching radium ore with Na_2CO_3 or K_2CO_3 and then with acid for Ra extraction is given.

80   Pohl, R. "Luminescence of Radium Bromide."
        Verhandl. deut. physik Ges. (2), 7, 458-64(1905).
It was possible that the effect on the photographic plate in the experiments of B. Walter and the author might be due to fluorescence of the quartz window in the neighborhood of the radium salt. Further experiments have shown that this is not the case, but that the air above the radium preparation actually becomes luminous.

81   Ramsay, W. "Decomposition of Water by Radium."
        Medd. Vetenskapskad. Nobelinst. 1, 909-11(1905).
It has several times been found that when water is decomposed by radium bromide an excess of hydrogen is obtained. One of the probable causes, which also frequently occurs, is oxidation of the grease of stopcocks. The emanation acting on pure water in absence of oxidizable substances gives a gas mixture which consists of H and O in explosive proportions.

82   Ramsay, W. "Action of Radium on Gelatin Media."
        Science 22, 405(1905).
A suggested explanation of the appearances observed by J. B. Burke. Minute grains of solid radium bromide sprinkled on a gelatin broth medium would sink slowly below the surface, where they would dissolve in and decompose the water, liberating oxygen and hydrogen, together with emanations, which would remain mixed with these gases. The gases would form minute bubbles, probably of microscopic dimensions, and the coagulating action of the emanation on the albumen of the liquor would surround each with a skin, so that the product would appear like a cell; its contents, however, would be a mixture of the gases oxygen and hydrogen. The emanation, enclosed in such a sack, would still decompose water, for enough would diffuse through the moist walls of the sack. The accumulation of more gas would almost certainly burst the walls of the cell in one or two places. Through the cracks more gas would issue, carrying with it the emanation, and with it the property of coagulating the walls of a fresh cell. The result of the original bubble would resemble a yeast cell, and the second cell a bud, or perhaps more than one, if the original cell happened to burst. This process would necessarily be repeated as long as the radium continued to evolve emanation. The "life," therefore, would be a long one, and the "budding" would impress itself on an observer as equally continuous with that of a living organism. (W.A.D. Rudge. Nature 72, 631(1905)). When radium-barium bromide, and also when various barium salts which did not contain radium, were placed upon sterilized gelatin, effects were observed which resembled the growth of an ordinary mould.

83   Rutherford, E. "Charge Carried by the α- and β-rays of Radium." Phil. Mag. (6), 10, 193-208, Aug. 1905.
A brief account of the results of this paper appeared earlier in Nature. The charge on the α-rays is detected by methods already given. The total charge emitted by a known weight

1905

of radium bromide, and carried by the α-rays, is measured by a comparatively simple method, and assuming the charge on each α-particle is ionic, it is deduced that 1 g. of radium bromide at its minimum activity expels 3.6×10^{10} particles per sec. Assuming the formula $RaBr_2$, the number for pure radium at its minimum activity is 6.2×10^{10}. The number from 1 gm. of radium in radio-active equilibrium is four times this amount and is equal to 2.5×10^{11}. This is in good agreement with the number 2×10^{11} previously deduced from the heating effect. It has been suggested that the α-particles are uncharged at the moment of expulsion. In these experiments the charge they carry is independent of the state of the vacuum over a considerable range, and this would not be expected if they gain their charge by collision and consequent loss of an electron. By a method similar to that used for the α-rays, the number of β-rays expelled per sec. from 1 gm. of radium is found equal to 7.3×10^{10}. Reasons are given why this number may probably be too high. The results indicate that four α-particles are expelled from radium in equilibrium for each β-particle. Knowing the number of α-particles expelled per sec., the magnitude of other important physical constants in radio-activity may be deduced. Thus the half-life for radium is calculated to be 1,280 years. The maximum volume of the emanation to be obtained from 1 g. of radium in equilibrium is 0.83 mm^3., while Ramsay and Soddy found experimentally about 1 mm^3. The emission of energy in the form of α-particles is calculated to be 126 cal./g./hr., in good agreement with 100 as found by Curie and Laborde.

84   Rutherford, E. and Boltwood, B. B. "Proportion of Radium and Uranium in Minerals." Am. J. Sci. 20, 55-6(1905).
It has been shown by both Boltwood and Strutt that the proportion of Ra to U in radio-active minerals is constant. The authors now seek to determine the weight of Ra in radio-active equilibrium with 1 g. of U and find it equal to 7.4×10^{-7} g. This is obtained by comparing the quantity of emanation obtainable from a mineral of known U content with that from a solution of the purest $RaBr_2$ obtainable. This amount is about that to be expected if U is the parent of Ra.

85   Rutherford, E. and Boltwood, B. B. "Proportion of Radium and Uranium in Minerals." Chem. News 92, 38-9(1905).
It has been shown by both Boltwood and Strutt that the proportion of Ra to U in radio-active minerals is constant. The authors now seek to determine the weight of Ra in radio-active equilibrium with 1 g. of U, and find it equal to 7.4×10^{-7} g. This is obtained by comparing the quantity of emanation obtainable from a mineral of known U content with that from a solution of the purest $RaBr_2$ obtainable. This amount is about that to be expected if U is the parent of Ra. This article is similar to the previous reference.

86   Soddy, F. "Production of Radium from Uranium."
        Phil. Mag. (6), 9, 768-79(1905).
1 kg. of uranium nitrate is dissolved in water, H_2SO_4 added, and then successive quantities of $Ba(NO_3)_2$ solution, filtering following each addition. The solution is enclosed in a bottle and air drawn through; testing by an electroscope shows that the solution is practically free from radium. This test has been repeated over a period of eighteen months, showing a

1905

gradual growth of radium in the solution. The amount of radium produced is only 1/1000 of the amount that should be produced on the assumption of a direct change from UX into radium. Any intermediate products whose life is long compared with the time of the experiments would account for this. Reasons are given for supposing that either bismuth or lead are the final products of the radio-active changes.

87   von Lerch, F. Monatsh. 26, 901(1905).
The author reports the half-life period of ThX(Ra²²⁴) to be 3.637 days.

88   von Lerch, F. Sitzber. math. - naturw. Klasse Akad. Wiss. Wien 114, 2a, 553(1905).
The separation of ThX(Ra²²⁴) by electrolysis in an alkaline solution is described. The separation does not take place in an acid solution.

89   Walter, B. and Pohl, R. "Luminosity of Radium Bromide." Ann. Physik (Wied.) (4), 18, 406-09(1905).
W. and Lady Huggins suggested that the luminosity of radium bromide was probably due to the impact of the β-rays against the nitrogen molecules of air, and that the light might therefore originate at some distance from the salt. This conclusion, which they were not able to confirm experimentally, is shown to be correct by experiments in which a long exposure was given to photographic plates screened from the radium salt but capable of receiving light emitted 2 cm. above it.

1906

90   Allen, S. J. "Velocity and e/m for the Primary and Secondary Rays of Radium." Phys. Rev. (1), 23, 65-94(1906).
The β- and γ-rays from radium are shot between two metal plates, which are at very different potentials, into a chamber containing an electroscope. By recording the leak with the field on and off, and also with a magnetic field in similar circumstances, v and e/m can be found. It is found, however, that the effects of the fields are much less than theory would indicate, both at atmospheric pressure and in a vacuum. This is shown to be due to the secondary and tertiary radiations emitted from the apparatus at places where the β-rays strike it. The primary β-rays, as before, pass between charged plates, but the somewhat large opening in the electroscope chamber is partially closed by a brass plate so that the direct rays do not enter. The primary and secondary rays can now be deflected, either by magnetic or electric fields, until they pass the edge of the brass plate. Knowing the values of the fields, v is found. A slightly modified arrangement, for purposes of calculation, gives mV/e; hence e/m is found. The values given are those possessed by particles which can just penetrate the electroscope chamber and cause ionization. They show that e/m decreases from 1.27×10^7 to 0.76×10^7 while V changes from 2.37×10^{10} cm./sec. to 2.88×10^{10} cm./sec. By stopping the primary rays, the secondary rays can be dealt with; e/m varies between 1.27×10^7 and 1.09×10^7 when V alters from 2.35×10^{10} cm./sec. to 2.58×10^{10} cm./sec.

91   Boltwood, B. B. "On the Production of Radium by Actinium." Am. J. Sci. 22, 537-8(1936).

1906

The solution obtained on dissolving one kilogram of carnotite in dilute hydrochloric acid was treated with hydrogen sulfide and the precipitated sulfides removed. To separate the actinium from the solution thus prepared 0.5 gram of thorium nitrate was added, followed by a solution of several grams of oxalic acid. The precipitated oxalates were converted into nitrates and again submitted to precipitation with oxalic acid. The oxalates, which were now assumed to contain all the actinium present in the mineral, were converted into chlorides and sealed up in a glass bulb. Two months later the emanation which collected was found to correspond to the presence in the actinium solution of 5.7×10^{-9} g. of radium. The bulb was again sealed up and allowed to stand 193 days longer before the gases and emanation were boiled off and tested. The amount of emanation now present corresponded to 14.2×10^{-9} g. of radium, an increase of 8.5×10^{-9} g. in the time stated, or at the rate of 1.6×10^{-8} g./year. From these results the author concludes that the period required for the decay of radium to one-half its initial value is about 3,300 years, and that actinium is the intermediate disintegration product between uranium and radium.

92   Boltwood, B. B. "Production of Radium from Actinium." Nature 75, 54(1906).
1 kg. of carnotite is treated so as to separate from it all the the AC, and the solution containing the latter is sealed in a glass bulb. About two months later the emanation is boiled off and tested. The activity corresponds to a content of 5.7×10^{-9} g. In 193 days 8.5×10^{-9} g. of Ra have been produced. This gives $\lambda(\text{year})^{-1}$ for Ra as 2.2×10^{-4}. The half-value period is about 3,100 y. It is noteworthy that the amount of Ac in a mineral is apparently always proportional to the amounts of U and Ra.

93   Boltwood, B. B. "Production of Radium from Actinium." Physik. Z. 7, 915-16(1906).
1 kg. of carnotite is treated so as to separate from it all the Ac, and the solution containing the latter is sealed in a glass bulb. About two months later the emanation is boiled off and tested. The activity corresponds to a content of 5.7×10^{-9} g. In 193 days 8.5×10^{-9} g. of Ra have been produced. This gives $\lambda(\text{year})^{-1}$ for Ra as 2.2×10^{-4}. The half-value period is about 3,100 y. It is noteworthy that the amount of Ac in a mineral is apparently always proportional to the amounts of U and Ra.
This article is similar to the previous reference.

94   Bragg, W. H. "The α-particles of Radium." Physik. Z. 7, 143-6(1906).
A discussion of some of the author's results in the light of more recent knowledge. If the ionization varies inversely as the nth power of the velocity, n is found nearly equal to 2.

95   Crookes, W. "Production of Helium from Radium." Chem. News 94, 144(1906).
A small vacuum tube having beads of radium bromide fused on to the ends of its Pt electrodes was exhausted and sparked, CO_2 being evolved: again exhausted and sparked, with further evolution of CO_2. No helium was, however, detectable. Examined after an interval of four months, the helium line $\lambda = 5875.9$ was distinctly visible. Although too faint to be measured, the parhelium line was also observable.

1906

96   Elster, J., and Geitel, H. Physik. Z. 7, 450(1906).
   The author reports the half-life period of ThX(Ra^{224})
to be 3.6 days.

97   Eve, A. S. "Radium in Minerals." Am. J. Sci. 22,
          4-7(1906).
   The author has previously shown that the γ-radiations
from radium, thorium, and radio-thorium are similar in
character and equally absorbed by lead, and that it is possible
to find the amount of these substances in a mineral by cutting
off the easily absorbed U and Ac γ-rays, and comparing the
remaining γ-radiation with that from a known weight of ra-
dium. He has used this method, but found it did not give re-
sults that were concordant with those obtained by the em-
anation method. This has been traced to the inconstancy of
the standard radium solution used in the latter method. It
is found that half of the salt has come out of solution. This
can be prevented by the addition of HCl. With a new standard,
Boltwood's results, obtained by the emanation method agree
with those of Eve by the γ-ray method. Incidentally it is
found that radium E gives out no γ-rays or else rays that are
easily absorbed.

98   Eve, A. S. "Relative Activity of Radium and Thor-
          ium." Am. J. Sci. 22, 477-80 Dec., (1906).
   The author determines the ratio of the γ-activities of ra-
dium and thorium when both are in radio-active equilibrium.
He also ascertains the relative amounts of radio-thorium in
thorianite and thorium nitrate respectively by measurement
of the γ-radiations. He finds that radium bromide is 4.5
million times as active as ThO$_2$ or that radium is 6.9 mil-
lion times as active as thorium, measured by the γ-rays,
when both are in radio-active equilibrium. The ratio of the
quantity of radio-thorium per g. of thorium present in thori-
anite and in thorium nitrate has been measured by Boltwood,
using the α-ray method and by Dadourian, using the emana-
tion method. The results so obtained are in good agreement
with the author's results obtained by the γ-ray method.

99   Himstedt, F. and Meyer, G. "The Spectrum Anal-
          ysis of the Self-Luminosity of Radium Bromide
          Crystals." Ber. deut. physik. Ges. 8, 433-6(1906).
   Crystals of radium bromide were fastened in the slit of
the spectroscope. The collimator was filled, in successive
experiments, with CO$_2$, CO, H$_2$, air, and He. In all cases the
photographs obtained after 7 to 10 days' exposure showed the
continuous spectrum of the phosphorescent light of the crys-
tals. In addition there was produced, in air, the band spec-
trum of N and in He apparently some of the lines of this
gas. None of the other gases gave characteristic lines. The
effect upon N and He is thought to be due to the α-rays.

100   Himstedt, F. and Meyer, G. "The Spectrum Anal-
          ysis of the Self-Luminosity of Radium Bromide
          Crystals." Physik. Z. 7, 762-4(1906).
   This article contains information similar to that shown for
the previous reference.

101   Hoffman, G. Ann. Physik (Wied.) (4), 21, 239(1906).
   The diffusion coefficient of ThX(Ra^{224})in water at 18° is
reported to be 0.66 cm^2/day.

1906

102   Huggins, W. and Huggins, Lady. "Spectrum of the
          Spontaneous Luminous Radiation of Radium." Proc.
          Roy. Soc. (London) A 77, 130-31(1906).
   It has been recently shown that the air immediately sur-
rounding a sample of radium bromide is glowing and shows
four of the bands of the nitrogen spectrum. The authors con-
firm this observation and extend it to include all the nitrogen
bands. When the radium salt is enclosed in a thin glass tube
the air immediately surrounding the tube is not rendered
luminous, which shows that the luminosity is not due to the
β-radiation which passes freely through glass.

103   Kohlrausch, F. and Henning, F. "Conductivity of
          Aqueous Solutions of Radium Bromide." Ann.
          Physik (Wied.) 20, 96-107(1906).

104   Kohlrausch, F. and Henning F. Verhandl. deut.
          physik Ges. (2), 6, 144(1906).
   Information on the electrical conductivity of RaBr$_2$·2H$_2$O.

105   Laine, V. J. "Absorption of β-rays of Radium."
          Physik Z. 7, 419-21(1906).
   The expression k $\sqrt[3]{Ad^2}$ is obtained, for the absorption
coefficient, α, of any material, for the β-rays of radium,
A being the atomic weight of the material, d its density, and
and k a constant. The relative absorption exhibited by plates
of different metals is found by a photographic method, and
$\alpha/\sqrt[3]{Ad^2}$ are tabulated. The values of the ratio all lie between
4.20 and 5.31, while α varies from 24 for Al to 193 for Pt.
The results of experiment are thus in good agreement with
the formula.

106   Levin, M. "On the Origin of the β-Rays Emitted by
          Thorium and Actinium." Phil. Mag. (6), 12, 177-88
          (1906).
   Ra^{224} was separated from radiothorium and the active de-
posit removed by heating on a platinum plate to a high tem-
perature. As soon as cold, separate measurements were
made of both the α- and β-ray activities. The β-ray activity
was found to be only 3.5% of the maximum reached one day
later, while the α-ray activity had an initial value of 60%.
Since during this time the activity of the ThX(Ra^{224}) had been
diminishing, the maximum observed is less than the theo-
retical value. When this was calculated, the initial value
for the β-ray activity is reduced to 2.61%, and that of the
α-ray activity of 48%, which represents the initial activity
due to both ThX and the emanation, since, on account of its
rapid change, the latter reaches its equilibrium in a few
minutes. If each of the four α-ray products present with
the ThX supply an equal proportion of the total equilibrium
activity, then the activity due to ThX and the emanation to-
gether should be 50% of the total. By similar reasoning if
ThX emits β-rays, the initial activity for the β-rays should
be also about 50%. Since it is only 2.61%, it is concluded
that the transformation of ThX into the emanation is ac-
companied only by the emission of α-rays. In a similar
way the initial β-ray activity of thorium containing radio-
thorium but free from subsequent products amounted to
only about 3%; from which it is likewise inferred that
neither thorium or radiothorium emit β-rays. Experi-
ments performed in a similar way show that AcX(Ra^{223}) and
its emanation give out only α-rays, while actinium itself

1906

rayless. The presence of the product radioactinium was confirmed, and a method was found for its separation from actinium. It was finally concluded that the β-rays from thorium in equilibrium arise only from ThC, while the β-rays from actinium are emitted by AcB.

107   Levin, M. "On the Origin of the β-Rays Emitted by Thorium and Actinium." Physik. Z. 7, 513-19 (1906).

This article contains information similar to that indicated for the previous reference.

108   Meyer, M. "The Fate of Radium after its Introduction into the Animal Organism, with Some Remarks on the Excretion of Barium." J. Biol. Chem. 2, 461-79(1906).

By whatever channel radium is introduced it seems to find its way into practically all the tissues and fluids of the body. It is eliminated to a certain extent in the urine and largely with the feces, in which it leaves the body continuously in small amounts. Its excretion may be continued over a long period. No observations were made on its removal through the skin or lungs. The range of distribution of radium in the body is influenced somewhat by the channel of its introduction as well as by the radioactivity (purity) of its compound and the time that elapses after its administration before the death of the animal. So far as its distribution and elimination are concerned radium is like the alkaline earths. Recent observations on the excretion of barium have been discussed.

109   Precht, J. "Radiation Energy of Radium." Ann. Physik (Wied.) (4), 21, 595-601(1906).

The amount of heat evolved per hr. from 25.02 mg. of radium bromide entirely free from water of crystallization was determined in an ice calorimeter with special precautions to insure accuracy. With the radium bromide inclosed in a small thin-walled glass tube this amounted to 122.2 cal./hr./g. radium. When the glass tube was surrounded by a cylinder of lead 2.9 mm. in thickness, the heat generated in the calorimeter now amounted to 134.4 cal./hr./g. radium, an increase of 10%. Increasing the thickness of the wall of the lead cylinder beyond 2.9 mm. produced no change in the amount of heat evolved. It is therefore concluded that this increase of 12.2 cal./hr/g. radium represents the energy of the β-radiation. From these data and assuming that the mean velocity of the β-particles is 2.5×10^{10} cm. per sec., the author calculates that the mass of the β-particles given off per hour from 1 g. of Ra amounts to 1.6×10^{-12}.

110   Precht, J. "The Radiant Energy of Radium." Ber. deut. physik. Ges. 8, 436-8(1906).

The heat produced by 0.025 g. anhydrous $RaBr_2$ was determined in a specially constructed ice calorimeter. The observed heating amounted, for 1 g. of radium in 1 hour, to 122.2 cal. when the radium compound was not surrounded by lead; to 126.9 cal. when covered with 1 mm. of sheet lead; and to 134.4 cal. for 3 mm. or more of lead. The difference between the last and first values is ascribed to the effect of the β-rays. Taking the velocity of the latter as 2.5×10^{10} cm./sec., the mass of the β-rays produced per hour from 1 g. of radium is 1.6×10^{-12} g. There appear to be two

1906

hydrates of radium bromide which contain $2H_2O$ and $6H_2O$, respectively.

111   Precht, J. "Explosion of Radium Tubes." Physik. Z. 7, 33-4(1906).

On Dec. 27, 1904, the author sealed up 25 mgm. of purest radium bromide in a glass tube of 2 mm. internal diam. and 0.5 mm. thickness of wall. It was finely powdered and desiccated. In Nov., 1905, it was several times immersed in liquid air. Three minutes after it had been removed from the bath and laid on a wooden table the tube exploded spontaneously, the glass being broken up into almost microscopic fragments. The radium was visible in the dark like a starry sky, and was recovered piecemeal. The pressure, no doubt due to emanation, must have been 20 atmospheres.

112   Precht, J. "The Radiant Energy of Radium." Physik. Z. 7, 836(1906).

The heat produced by 0.025 g. anhydrous $RaBr_2$ was determined in a specially constructed ice calorimeter. The observed heating amounted, for 1 g. of radium in 1 hour, to 122.2 cal. when the radium compound was not surrounded by lead; to 126.9 cal. when covered with 1 mm. of sheet lead; and to 134.4 cal. for 3 mm. or more of lead. The difference between the last and first values is ascribed to the effect of the β-rays. Taking the velocity of the latter as 2.5×10^{10} cm./sec., the mass of the β-rays produced per hour from 1 g. of radium is 1.6×10^{-12} g. There appear to be two hydrates of radium bromide which contain $2H_2O$ and $6H_2O$, respectively.

113   Rinne, F. Jahrb. Radioakt. u. Elektronik 3, 239 (1906).

The author reports that $RaBr_2$ is isomorphous with $BaBr_2$ $2H_2O$ and crystallizes in the monoclinic system.

114   Rutherford, E. "Properties of the α-Rays from Radium." Phil. Mag. (6), 11, 166-76(1906).

Becquerel has questioned the views of Rutherford and Bragg that the α-rays from radium are not homogeneous, and that their velocity is altered by passing them through layers of aluminum-foil. Rutherford's experiments, here described, conclusively uphold his own views, and he further shows that Becquerel's experimental results can be simply explained by the same theory. The α-rays from one half of an active wire in an evacuated space pass through aluminum; from the other half proceed without obstruction to a photographic plate. An image of a fine slit is thus obtained both with and without a magnetic field acting on the rays. The deviation so produced is much greater for those rays which have passed through aluminum. If a salt of radium is used instead of the active wire, dispersion of the rays is clearly shown, proving that they are not homogeneous. For the author's explanation of Becquerel's results see the original paper.

115   Rutherford, E. and Boltwood, B. B. "Radium and Uranium in Minerals." Am. J. Sci. 22, 1-3(1906).

In a previous paper it has been found that 7.4×10^{-7} g. of radium is in equilibrium with 1 g of uranium in minerals. Later work has shown that the radium standard is not constant, and a revision of the work was necessary. The revised number is 3.4×10^{-7} g. of Ra/g. U.

1906

116   Swinton, A. A. C. "Radium and the Visible Electric
        Discharge in Vacuo." Phil. Mag. (6), 12, 70-3(1906).
   It is found that the presence of radium on the cathode mate-
rially increases the amount of current that passes through a
vacuum tube with any given voltage. When the radium is not
heated the effect is not noticed, but when the radium-coated
cathode was heated to redness there was a very marked ef-
fect in facilitating the production of a luminous discharge.
A strip of Pt-foil was used in some experiments; this before
mounting in the tube was dipped into a solution of radium
bromide and dried. The amount of radium on the foil must
have been extremely small, but with a suitable vacuum, and
with the cathode heated to a bright red color, the discharge
passed and the gas in the tube lighted up brightly with elec-
trical pressures as low as about 80 volts. In various other
cases it was always found that a visible discharge could be
made to pass, using the radium-treated electrode, with
about 100 volts less than when the untreated electrode was
employed.

117   Walter, B. "Photographing Radium Particles by
        Their Own Light." Ann. Physik (Wied.) 19, (4),
        1030-1(1906).
   The author has taken photographs of grains of radium
bromide by means of the light emitted from the radio-active
substance. Such photographs are not reproduced yet owing
to their want of sharpness, due to the unsuitability of ordi-
nary photographic lenses for work in the ultra-violet region.
The plates obtained have, however, shown that there are al-
ways some parts which show a greater, and others a less
marked brightness; this is believed to be due not to non-uni-
formity in the distribution of the activity, but, from micro-
scopic examination, to the fissured condition of the salt at
the more active portions, allowing more of the emanation
to escape.

118   Walter, B. "Radium and Helium." Nature 75, 102
        (1906).
   Referring to the hypothesis that radio-active phenomena
are associated with atomic degradation, and that the loss of
an atom of helium (atomic weight 4) frequently accompanies
such changes, it is observed that the transformation of the
uranium atom (238.5) into radium (225) occurs owing to the
loss of three helium atoms, while the change of radium into
lead (206.5) is due to the loss of five such atoms. The dis-
crepancy in the numbers, $238.5 - 3 \times 4 = 226.5$ instead of
225, and $225 - 5 \times 4 = 205$ instead of 206.5, can be satis-
factorily accounted for if it is assumed that the atomic
weight of radium is not 225 but 226.5, for then $238.5 - 3
\times 4 = 226.5$ and $226.5 - 5 \times 4 = 206$ 5. This assumption of a
slightly higher atomic weight for radium than that found by
M. Curie does not appear unwarranted, as the values given
for the atomic weight of radium have become greater and
greater as the material used in the determination has been
obtained increasingly purer.

1907

119   Boltwood, B. B. Am. J. Sci. (4), 24, 93(1907).
   The precipitation of the $\overline{MsTh_1}$ (Ra^{228}) salt from a so-
lution of thorium salts with NH_3 is described, as is the
pptn. of ThX(Ra^{224}).

1907

120   Boltwood, B. B. Physik. Z. 8, 559-60(1907).
   The precipitation of the $\overline{MsTh_1}$ (Ra^{228}) salt from a so-
lution of thorium salts with NH_3 is described, as is the
pptn. of ThX(Ra^{224}).

121   Bronson, H. L. "The Effect of Temperature on the
        Activity of Radium and Its Transformation Products."
        Chem. News 95, 39-42(1907?)
   A few tenths of a milligram of pure radium bromide were
sealed in a quartz tube under diminished pressure, and
placed in a small electric furnace directly beneath an
electroscope which was protected from convection currents
by being surrounded by two layers of asbestos and one of
lead. The temperature of the furnace was gradually raised
to 1600°, and simultaneous observations of temperature and
activity taken at intervals of two or three minutes. The
length of time during which the temperature was above
1500° was sufficient to have made it possible to detect a
variation of 1% in the rate of transformation of the ema-
nation, RaB or RaC, but there was no evidence of any change
in the activity as thus measured by the penetrating γ-rays.
The results obtained by Makower (Proc. Roy. Soc., 77, 241),
who concluded that the rate of decay of RaC is increased by
high temperatures, is explained by the author on the assump-
tion that the RaC volatilized and deposited itself near the
ends of the tube.

122   Curie, M. "The Atomic Weight of Radium."
        Compt. rend. 145, 422-5(1907).
   A redetermination of the atomic weight of radium was
made using 0.4 gram of pure radium chloride. The purifi-
cation process consisted, as in the previous determination,
of fractional crystallization from water containing HCl. To
guard against the formation of radium sulphate, which in-
creased the difficulty of purification, all the reagents used
had to be specially purified to remove the last traces of
sulphuric acid. The method employed for the determination
of the atomic weight was the same as previously used. It
consisted in estimating, as silver chloride, the chlorine
contained in a known weight of the anhydrous radium chloride.
Three determinations all of which agreed closely, gave for
the atomic weight of radium, the mean value 226.18 (H = 1)
or 226.45 (0 = 16.00), assuming that radium is a bivalent
element. The value previously found was 225. The author
attributes the difference in the numbers to less pure reagents
used in the older determinations, and to inferior accuracy
of the experiments which were performed with only 90 mg.
of radium salt.

123   Eve, A. S. and Adams, F. D. "The Effect of Pres-
        sure on the Radiation of Radium." Nature 76, 269
        (1907).
   Barium-radium chloride, together with the emanation, A,
B, and C, contained in a nickel steel cylinder was subjected
to pressures up to 20,000 atms., the estimated pressure at a
depth of 50 miles below the earth's surface. From this fact
it is concluded that radium generates heat by disintegration
equally at the surface of the earth and at depths of 40 or 50
miles beneath the surface. Judging from the known tempera-
ture gradient of the earth's crust and the amount of radium
found in rocks, it is concluded that the radium content of
the interior of the earth must be smaller than that near the
surface.

1907

124   Fleck, H., Haldane, W. G., and White, F. L.   U. S.
       Pat. 890,584 (1907).
    A method for leaching radium ores with H_2SO_4 is described.

125   Giesel, F. Ber. 40, 3011(1907).
    The separation of AcX (Ra^{223}) from actinium preparations
by the precipitation of the actinium with ammonia is de-
scribed. The AcX remains in solution.

126   Hahn, O. "Origin of Radium." Ber. 40, 4415-20
       (1907). Abstract in Nature 77, 30-1(1907).
    An account of experiments supporting Boltwood's con-
clusions concerning the parent substance of radium, and
showing that it possesses chemical properties closely
allied to thorium. It has been noticed that old preparations
of pure thorium contain relatively large amounts of radium;
and this is the more noteworthy since the monazite sand from
which the thorium is prepared contains but little uranium. A
systemic study of the quantity of radium in samples of
thorium salts of different ages has been undertaken. An
aqueous solution of pure nitrate is made, boiled, and sealed
up. After a sufficient interval the Rn is collected by boiling
the solution, and after allowing time for the thorium emanation
to decay, is transferred to an electroscope and measured. It
is found that the older the sample the larger the quantity of
radium contained in it. This cannot be ascribed to insufficient
purity, nor is it probable that thorium itself decomposes into
radium. It is therefore probable that in the technical prepa-
ration of thorium an active substance is separated with the
latter, and that this is the direct parent of radium. Various
tests are given showing the growth of radium in thorium
solutions. A solution of radio-thorium is prepared from
thorianite using $BaSO_4$; this does not contain the parent
substance. Knowing the proportions of uranium and
thorium in monazite sand, and assuming that all the thorium
and parent substance are separated therefrom during the
extraction of thorium, the life of radium can be calculated
by determining the quantity of radium in a given weight of
thorium of known age. The period of decay lies between
2,000 and 3,000 years.

127   Hahn, O. "Origin of Radium." Chem. News 96,
       272-3(1907). Abstract in Nature 77, 30-1(1907).
    An account of experiments supporting Boltwood's con-
clusions concerning the parent substance of radium and
showing that it possesses chemical properties closely
allied to thorium, it has been noticed that old preparations
of pure thorium contain relatively large amounts of radium;
this is the more noteworthy since the monazite sand
from which the thorium is prepared contains but little urani-
um. A systemic study of the quantity of radium in samples
of thorium salts of different ages has been undertaken. An
aqueous solution of pure nitrate is made, boiled, and sealed
up. After a sufficient interval the Rn is collected by boiling
the solution, and after allowing time for the thorium ema-
nation to decay, is transferred to an electroscope and
measured. It is found that the older the sample the larger
the quantity of radium contained in it. This cannot be
ascribed to insufficient purity, nor is it probable that
thorium itself decomposes into radium. It is therefore
probable that in the technical preparation of thorium an
active substance is separated with the latter, and that this is
the direct parent of radium. Various tests are given showing

1907

the growth of radium in thorium solutions. A solution of
radiothorium is prepared from thorianite using $BaSO_4$;
this does not contain the parent substance. Knowing the
proportions of uranium and thorium in monazite sand, and
assuming that all the thorium and parent substance are
separated therefrom during the extraction of thorium, the
life of radium can be calculated by determining the quantity
of radium in a given weight of thorium of known age. The
period of decay lies between 2,000 and 3,000 years.

128   Kolowrat, L. "The Evolution of Emanation from
       Radium Salts at Different Temperatures." Compt.
       rend. 145, 425-8(1907).
    The rate of evolution of radium emanation by barium-
radium chloride, of activity 250 times uranium, was
measured at various temperatures. During the heating,
the radium preparation was held in a platinum tube, en-
closed in a quartz glass tube. The emanation retained by
the solid chloride is completely evolved, in a very short
time, at the melting point of the salt, about 945°. The
barium-radium chloride, which has been fused and allowed
to solidify, gives off only 1% of its emanation at ordinary
temperature. The fraction of the emanation evolved in-
creases with temperature up to 830°. Between 830° and
920° an abnormally small fraction of the emanation was
evolved. Barium-radium fluoride also showed an abnormally
small evolution of emanation between 960° and 1130°.

129   Kolowrat, L. Radium 4, 319(1907).
    The preparation of RaF_2 is described.

130   McCoy, H. N. and Ross, W. H. J. Am. Chem. Soc.
       29, 1718(1907).
    The authors report the half-life of $MsTh_1$ (Ra^{228}) to be
5.5 years.

131   Meyer, S. and von Schweidler, E. Sitzber. math.-
       naturw. Klass. Akad. Wiss. Wien 116, 2a, 319(1907).
    The half-life period of AcX (Ra^{223}) is reported to be 11.8
days.

132   Porter, A. W. "Decomposition of Radium Bromide."
       Nature 76, 151(1907).
    On opening a tube of radium bromide a strong odor of
bromine was noticed. It is calculated from the time the
tube had been closed that 2×10^{-7} g Br would be present,
and it is asked whether this would be detectable by its
odor. A. C. G. Egerton (Ibid. 174(1907)) states that the
minimum quantity of bromine that is detectable by smell
is between 10^{-8} and 10^{-10} g/cc.

133   Riecke, E. "Some Properties of Radium Atoms.
       (I) The Transformation Constant and the Half-Life
       of the Radium Atom." Nachr. Ges. Wiss. Göt-
       tingen 2, 163-70(1907).
    The determination of these constants is approached from
three different points of view: The first method, as developed
by Ramsay, depends upon the volume of emanation evolved
by a gram of radium in a unit of time. The radioactive
constant of radium is expressed by $rsv/2$, in which r = 225,
the at. wt. of radium; s = 0.0000898 the wt. of a cc. of
hydrogen, and v = the volume of the emanation given up by
1 g. of radium in 1 sec. From this $\lambda = 0.303 \times 10^{-10}$. Based

1907

on this result the period of radium is 1040 years. The second method makes use of the spontaneous heating effect produced by a radium compound. The author assumes that the heating is due solely to the absorption of the α-rays within the radium itself. By this method of calculation $\lambda = 0.31 \times 10^{-10}$, and the period of radium is 1030 years. The third method, that of Wein, based on a measurement of the electric charge acquired by a tube of radium protected by an aluminum jacket is criticized as being unreliable.

134   Rudge, W. A. D. "The Action of Radium and Certain other Salts on Gelatin." Proc. Roy. Soc. (London) 78A, 380-4(1907).

The formation of bacteria-like cells first observed by Burke to take place when a gelatin culture medium was treated with a speck of radium salt, and to which was given the name Radiobes (Nature 72, 78), was likewise found to be produced when the gelatin was treated with a salt of barium, strontium, or lead. No growth took place when salts of metals were used having soluble sulfates. If care was taken to remove all traces of sulfuric acid from the gelatin, a growth was not found to take place in any case until a soluble sulfate was added. Negative results always followed the use of thorium or uranium salts. Experiments with a high power microscope failed to show any trace of a nucleus or any evidence of subdivision or budding in any of the cell-like forms obtained. The author, therefore, concludes that there is no connection between radioactivity and the formation of the cells; that they are not organized bodies, but due simply to the precipitation of barium sulfate.

135   Rutherford, E. "Production of Radium from Actinium." Nature 75, 270-1(1907).

In the Bakerian lecture for 1904 the author gave a brief account of experiments he had commenced to see whether actinium produced radium. From a solution of actinium in acid the greater part of the radium was removed by precipitating barium in the solution. The radium remaining was determined by the emanation method and comparison with a standard solution of radium. No certain evidence was obtained over a period of 3 months that the amount of radium had increased. For various reasons the solution was not further tested for 2 1/2 years, but since Boltwood's experiments appeared further measurements have been made on it. Preliminary measurements showed a large growth of radium, but unfortunately the solution was contaminated with radium while these were in progress. The original salt from which the solution had been prepared was available and its radium content had, at that time, been determined. Experiments with this now show an increase of at least four times the initial amount of radium in 2 1/2 years. The earlier failure to observe these effects is ascribed to the unsuitable chemical treatment used to separate the radium from the actinium, giving rise to an excess of H_2SO_4 in solution, which would precipitate the radium as sulfate. In this condition only a small portion of the emanation would be removed by drawing air through the solution. The contaminated solution has now been successfully freed from radium, except for a minute quantity, and the growth of this substance observed over a period of five weeks. This growth amounts to 80% of the initial value. At this rate the

1907

amount of radium in solution should be eight times its initial value at the end of one year. This production of radium might arise, not from the actinium itself, but from another substance normally separated from the radioactive mineral with the actinium. A comparison of the actual rate of growth with that to be expected on the simple theory that actinium is transformed directly into radium shows that the two agree if the period of half transformation of radium is about 2,600 years. Such an agreement, however, implies that the activity due to actinium in pitchblende is about equal to that of radium and its products, and this is not the case, as Boltwood has shown. If radium arises from actinium, it should be produced by AcA and AcB. An active deposit from actinium is produced on a platinum plate, and the rate of growth of radium is found not more than 1/5 of the theoretical amount. This may be due to the presence of another change between AcB and radium, or, what is more probable, to the loss in an electric field of the radium formed on the plate. There is no doubt that the immediate parent of radium is present in actinium from pitchblende, but it is not definitely proved that radium is the direct lineal descendant of actinium.

136   Rutherford, E. "Origin of Radium." Nature 76, 126(1907).

It has been pointed out in a previous paper that although radium is produced in preparations of actinium there is no definite evidence that actinium itself is the true parent of radium. In the solution previously used it is found that the growth of radium is uniform over 120 days. By successive precipitation with ammonium sulfide an actinium solution has been obtained which initially is almost entirely free from radium, but which contains an excess of radio-actinium. The radium again grows at a uniform rate, but 1.5 times greater than the normal. This indicates that the radium-producing substance is present in excess of the normal amount. After suitable chemical treatment a small precipitate of actinium is obtained which is 100 times as active as the original preparation. This is dissolved in HCl, and in this solution no appreciable growth of radium has been observed over 80 days. It is therefore concluded that in commercial preparations of actinium there exists a new substance which is slowly transformed into radium. It is not possible at present to decide whether this substance is a final transformation product of actinium; it may be a product between UX and radium, in which case the position of actinium in the radio-active series still remains unsettled.

137   Rutherford, E. "Production and Origin of Radium." Phil. Mag. (6), 14, 733-49(1907). (Paper read before the British Association at Leicester, August 1907.)

The results presented in this paper have been previously reported in papers which are noted above. The data is, however, given a more rigorous mathematical treatment.

138   Salant, W. and Meyer, G. M. "The Elimination of Radium from Normal and Nephrectomized Animals." Am. J. Physiol. 20, 366-77(1907?).

In dogs and rabbits the kidney, liver and small intestine eliminate radium; in normal rabbits the large intestine also, though the passage through its wall is probably much less. Its elimination into the coecum of rabbits is slight or

1907

absent. Nephrectomized rabbits eliminate through the liver and small intestines at a rate no more rapid than normal. There does not seem to be any vicarious elimination elsewhere except possibly through the stomach.

139   Schuster, A. "The Effect of Pressure on the Radiation from Radium." Nature 76, 269(1907).
   It was shown by experiments, the details of which are not given, that the radioactivity of radium is not altered by as much as one-third per cent, by a pressure of 2000 atms.

140   Soddy, F. "Origin of Radium." Nature 76, 150 (1907).
   Soddy has previously found that uranium gives rise to radium, but only to 1/1000th of the amount it should, theoretically, if the radium is produced directly. Boltwood, on the other hand, found no such growth, and therefore concluded that Soddy's results are without significance. It is here pointed out that the uranium solutions used by these two observers were purified in different ways, and therefore it is quite possible that intermediate products were removed in one case and not in the other, thus accounting for the contradictory results obtained. This view is supported by the recent experiments of Rutherford on the production of radium by actinium.

141   Soddy, F. and Mackenzie, T. D. "Relation between Uranium and Radium." Phil. Mag. (6), 14, 272-95 (1907).
   The first part of the paper summarizes what has been done to show the production of radium from uranium. In the old experiments of Soddy the uranium was freed from radium by repeated precipitation of barium as sulfate. After 550 days the radium content had increased a hundredfold, but was still much less than was expected theoretically, this being probably due to the formation of intermediate products. According to the process of purification initially adopted these intermediate products may or may not be removed; a new method of purification has now been used, viz., the solution of uranyl nitrate in ether. The first experiments started in Oct., 1905; the results on this sample of uranium to-date show that the amount of radium produced in 600 days by 250 g. of uranium is too small to be conclusive. In another experiment the gases from the solutions are being stored and tested in case a rayless change intervenes. A third experiment leaves it doubtful whether radium has been produced in a quantity of UX; further time is required. Other experiments show that the residual activity of actinium is not due to radium. The paper is rather a description of experiments that are in progress than of results attained.

1908

142   Bogorodskii, V. A. "Energy of Radium." J. Russ. Phys.-Chem. Soc. 40, 460-5(1908).
   A table is given showing the enormous amount of heat given off during the whole life of 1 g. of Ra as compared with the heat of formation of H_2O and the heats of explosion of $C_3H_5(NO_3)_3$ and pyroxylin. The author draws attention to the fact that chemists have so far failed to give Mendeleeff due credit for having predicted in 1871 the existence of an element of the at. wt. of about 230.

1908

143   Boltwood, B. B. "Life of Radium." Am. J. Sci. 25, 493-506(1908).
   The early part of the paper gives a summary of the methods that have been used to fix the half-life period of radium. The later part gives a new method of determining this constant independently of the purity of all standards, and hence resting on the smallest amount of assumption. If the amount of radium in a mineral in equilibrium with its parent substance, ionium, be determined, Io say, and the amount of dI produced in unit time, one year, by this same quantity of ionium be also found then the constant, λ, of radio-active change is the ratio dI/Io. Both dI and Io are found by measuring the leak produced in an electroscope by the emanation boiled out of a solution of the mineral. A solution of the mineral is made, and the emanation from a definite quantity is measured; this gives Io. The ionium is then separated from radium, and the quantity of the latter produced in a known time is also determined by the emanation method. Correction is made for the decay of the emanation in the period between successive tests. The final result shows that the half-life of radium is 2,000 years.

144   Dewar, J. "The Rate of Production of Helium from Radium." Chem. News 98, 188-90(1908).
   The rate of production of He from 70 mg. of Ra was calculated from the increasing pressure produced in a McLeod gauge and measured by a radiometer. All adventitious gases generated in the apparatus other than H_2 or He were absorbed by means of coconut charcoal cooled in liquid air. At the beginning of the experiment an exhaustion of 0.000044 mm. was obtained. During 5 days a steady growth of pressure was observed corresponding to an increment of approx. 0.3 mm.^{3}/g. Ra/day. At the end of this time the Ra in the apparatus was heated to a low red heat, which resulted in an increase of pressure of about 40%. During the following week the pressure showed no sign of decreasing and on again heating a further increase was observed. This treatment was repeated ten times at varying intervals during 1100 hours. In each case the pressure rose on heating, and remained fairly steady on standing. The quantity of permanent gas produced up to the end of the experiment corresponded to an increment of 0.37 mm.^{3}/g. Ra/day. A preliminary and less satisfactory experiment gave a daily increment of 0.417 mm.^{3}/g. Ra. Additional experiments were described which verified the purity of the He producing the permanent pressure and which proved that no gas was occluded either in the cooled charcoal or the surrounding glass.

145   Dewar, J. "The Rate of Production of Helium from Radium." Proc. Roy. Soc. (London) A, 81, 280-6(1908).
   70 mg. of $RaCl_2$, was used. The apparatus for the measurements was a McLeod gauge without India-rubber joints, the Hg reservoir being connected to an exhaust pump, while the elevation and lowering of the Hg was carried out by admitting and exhausting air in the reservoir. Sealed on to the gauze was a long U-tube containing 1 g. of coconut charcoal placed in an enlargement at the bend, the whole being arranged for cooling by means of liquid air. The object of the charcoal was to take up all adventitious gases, other than H_2 or He. The $RaCl_2$ was contained in a small bottle standing in a cylindrical glass bulb connected by a T-joint

1908

to the U-tube. To the other arm of the T was sealed a bulb containing about 15 g. coconut charcoal for producing high exhaustion in the apparatus when cooled to $-190°$. An exhaust of 0.000054 mm. could be obtained. The increase in pressure in the apparatus due to the formation of He was noted from time to time, the $RaCl_2$ being occasionally heated to liberate occluded He. The first experiment gave a result of 0.417 mm.^{3}/g. Ra/day taken over the whole period. A second experiment gave 0.37 mm.^{3}/day and differs from that of Cameron and Ramsay which was about eight times as large.

146   Fleck, H., Haldane, W. G., and White, F. L. U. S.
        Pat. 890,584 (1908).
    A method for leaching radium ores with H_2SO_4 is described.

147   Hahn, O. Physik. Z. 9, 404(1908).
    The author reports the half-life of $MsTh_1$ (Ra^{228}) to be 6.7 years.

148   Haitinger, L. and Ulrich, K. Monatsh. 29, 490(1908).
    The separation of $RaCl_2$ by fractional crystallization is described.

149   Haitinger, L. and Ulrich, K. Sitzber. math.-naturw.
        Klasse Akad. Wiss. Wien 117, IIA, 614-19(1908).
    The separation of $RaCl_2$ by fractional crystallization is described. The leaching of pitchblende for Ra recovery using alkali and dil. H_2SO_4 is also described.

150   Marchwald, W. Ber. 41, 1529(1908).
    Article on the leaching of pitchblende with H_2SO_4 and HNO_3, and the extraction of $RaSO_4$ with alkali.

151   Perman, E. P. "Action of Radium on Copper and
        Gold." J. Chem. Soc. 93, 1775(1908).
    Results are negative. Layers of $RaBr_2$ and $Cu(NO_3)_2$ were formed in separate silica capsules by evaporating solutions of the salts. The capsules, facing each other, were placed in a glass tube and exhausted to 0.1 mm. After 3 months no Li was found. $RaBr_2$ of strength 1,800,000 was allowed to act on $CuSO_4$ in the same way. No Li was found. $RaBr_2$ and $AuCl_3$ were allowed to stand in solution 4 months. No Li was found. A direct-vision Hilger spectroscope capable of detecting 0.000,001 mg. Li was used. $RaBr_2$ will not convert 1.0×10^{-8} its weight of Cu or 0.5×10^{-8} of Au into Li per day.

152   Perman, E. P. "Action of Radium on Copper and
        Gold." Proc. Chem. Soc. 24, 214(1908).
    This article contains similar information to that indicated for the previous reference.

153   Ramsay, W. "The Instability of Radium Bromide."
        Monatsh. 29, 1013-16(1908).
    In 1907, 0.5 g. $RaBr_2$ was sealed up and sent to Sir William Ramsay in London, but upon its arrival it weighed only 0.388 g. It was partly soluble in water, and gave off H, O, and Br in dissolving. Curious physiological effects appeared eight months after exposure to the salt.

154   Ramsay, W. "Instability of Radium Bromide."
        Sitzber. math.-naturw. Klasse Akad. Wiss. Wien
        117, 2a, 943-6(1908).

1908

A specimen of radium bromide weighing 0.5 g. is found after a time to be reduced in weight to 0.388 g. These experiments are carried out in order to find the cause of this decrease in weight. A weighed specimen is compared as regards activity, with a weighed quantity of pure radium chloride. For this purpose the discharging effects of beta and gamma rays are used. Then both the specimens used are treated with pure hydrobromic acid until their weights are constant. Calculations based on the results of these experiments show that 0.388 gm. of the salt are equivalent to 0.4971 gm. $RaBr_2 \cdot 2H_2O$. Other experiments indicate that the original salt must, in the two years since its preparation, have been changed into carbonate. When the original salt is treated with water the gas collected consists mainly of oxygen with comparatively small quantities of CO_2, hydrogen, nitrogen and helium.

155   Rutherford, E. and Geiger, H. Proc. Roy. Soc.
        (London) A81, 141-62(1908).
    The authors report that the number of α-particles emitted per second by 1 g. of Ra is 3.4×10^{10} and the half-life is calculated therefrom.

156   von Schweidler, E. and Hess, V. F. "Generation
        of Heat by Radium." Sitzer. math.-naturw. Klasse
        Akad. Wiss. Wien 117, 2a, 879-88(1908).
    The following table is given to show the results obtained, and methods adopted by previous observers, for estimating the quantity of heat given out by 1 g. of the radium metal:

Author	Preparation	Method	g. cal/hr
P. Curie and A. Laborde	1 g. 17 per cent bromide	—	100
C. Runge and J. Precht	—		105
E. Rutherford and H. T. Barnes	30 mg. pure bromide	Differential air thermometer	110
J. Precht	34 mg. pure bromide	Ice calorimeter	113.3
K. Ångström	90 mg. pure bromide	Electrical compensation calorimeter	117
J. Precht	25 mg. pure bromide	Ice calorimeter	134

The radium preparation used in the present experiments was 1.0523 g. of radium-barium chloride, dried at 130°C. and containing 0.7951 g. of metallic Ra, on the basis of the atomic weight of Ra = 226. The principle on which the quantity of heat generated is estimated is as follows: Two calorimeters having as nearly as possible equal capacities for heat are placed in a space which is kept at a constant temperature. One calorimeter is heated by radium, and the other by passing a known current through a heating spiral. The current is so regulated that both calorimeters are kept at the same temperature. It is found that the quantity of heat generated by 1 g. of radium metal in one hour is 118.0 g.-cal. The probable error is estimated to be not more than 1.4%. With reference to the rays used in these experiments it is re-

1908

marked that only those rays are not used which could penetrate 1 mm. of glass and 5 mm. of copper.

157   von Schweidler, E. and Hess, V. F. "The Heat
       Development of Radium." Monatsh. 29, 853-62
       (1908).
    The rate of production of heat by a known mass of Ra was measured by the method of Ångström, a differential colorimeter with compensation by electrical heating and with thermo-electric temperature measurement being used. The RaCl$_2$ used was dried at 130° and weighed 1.0523 g. The material was probably 99.7% pure, assuming 226 as the at. wt. of Ra. As a final result it was found that 1 g. of pure Ra (element) containing the equilibrium amounts of the emanation, A, B and C (and perhaps also enough F to add 1/2% to the activity), produced 118.0 g. cal./hr. The error of the heat measurement is estimated as 0.4%, the possible error in Ra content 0.5%, and the uncertainty in the activity due to RaF, 0.5%; a total error of ±1.4%. Other observers have found from 100 to 134 cal. per hr.

158   Soddy, F. "The Relation Between Uranium and
       Radium (III)." Phil. Mag. (6), 16, 632-8(1908).
    The results reported confirm the original experiment, started in 1903, in showing the existence of a minute quantity of a radium-producing substance in commercial uranyl salts. In the specimens tested the amount present was always below one part in a thousand of the theoretical equilibrium quantity which should be present in the natural mineral. In one of the carefully purified salts prepared by T. D. Mackenzie in 1905, the growth of Ra is not greater than 5×10^{-11} g. per kilo of uranium in 2-3/4 yrs. and in the other sample it is not more than 10^{-11} g. per kilo in 1-2/3 yrs. Assuming that only one intermediate body between U and Ra exists, its average life must not be less than 16,500 yrs., or six times that of Ra; so that at least six times more of it than of Ra must exist in minerals. Assuming that two intermediate bodies exist, with equal periods, each must not have a half-life of less than 100 yrs.

159   Thorpe, T. E. "Atomic Weight of Radium."
       Chem. News 97, 229-33(1908). (Bakerian Lecture
       for 1907.)
    The mean value of the atomic weight determined by the author is 226.7.

160   Thorpe, T. E. "Atomic Weight of Radium."
       Proc. Roy. Soc. (London)A 80, 298-309(1908).
       (Bakerian Lecture for 1907.)
    The mean value of the atomic weight determined by the author is 226.7.

161   Thorpe, T. E. "On the Atomic Weight of Radium."
       Z. anorg. Chem. 58, 443(1908). (Bakerian Lecture
       for 1907.)
    500 kg. of pitchblende from the mines at Joachimsthal were worked up by Armet de Lisle at his factory and the 413 g. of BaCl$_2$ obtained showed an activity of 560 times that of uranium. The author obtained from this, by the method of M. Curie, 64 mg. of radium chloride, the manipulations involved some 9400 recrystallizations. The chloride was precipitated by silver nitrate in a little weighing flask and washed by decantation, a method that seemed

1908

justified in view of the small quantity of material worked upon. The first determination gave 226.8 as the atomic weight of radium. After reconverting to the chloride a second determination gave 225.7. The radium was recovered and combined with 24 mg. of radium chloride from another source and the 78.4 mg. of radium chloride gave 75.3 mg. of silver chloride, which indicated 227.7 as the atomic weight of radium. The author considered that the preparation used did not contain enough BaCl$_2$ to affect the result, which may be taken as 227, measurably.

162   Ulzer, F. and Sommer, R.   German Pat. 254,241
       (1908).
    In the manuf. of crude sulfates enriched with radium, the Ra-containing materials are heated with conc. H$_2$SO$_4$, or are allowed to remain in contact therewith for a long time, or are fused with acid sulfates, then washed with H$_2$O, decanted, and filtered. The filter residue is heated, under increased pressure, with alkali or alkali carbonates, or mixts. thereof, or it is fused therewith. The residue after washing out and filtering yields crude Ra sulfate by heating with dil. H$_2$SO$_4$ and filtering.

163   Wilde, H. "On the Atomic Weight of Radium."
       Mem. Proc. Manchester Lit. & Phil. Soc. 52, No. 1,
       1-3(1908).
    The author submits a table of multiple differences between known atomic weights from which he deduces a factor method for anticipating unknown atomic weights. From this table and from the relations of the specific gravities of the alkali earth metals to their atomic weights and the similar relations of the alkali metals he assigns to Ra an atomic weight of 184. The author's results on the combining weight of Ra after the method of Marignac and Dumas are given in confirmation of his theoretical conclusions.

164   Wilde, H. "Atomic Weight of Radium." Phil. Mag.
       (6), 15, 280-2(1908).
    The combining equivalent of radium chloride with Ag, determined by the method of Marignac and Dumas, is 1.176 : 1, whence the combining weight of radium with chlorine is 92, or exactly one-half the atomic weight of 184 already assigned to the element by the author for considerations of periodicity.

1909

165   Bleecker, W. F. U. S. Pat. 1,015,469 (1909).
    A method for leaching carnotite with NaCl and NaOH for Ra recovery is reported.

166   Debierne, A. "The Decomposition of Water by the
       Salts of Radium." Compt. rend. 148, 703-5(1909).
    The rate at which gas is given off from a solution of a salt of Ra in water was observed for a period of over 6 months. Contrary to the results found by Ramsay, the rate at which the gas was evolved remained constant and in the case of RaCl$_2$ amounted to 13 cc./day/g. of Ra. That the decomposition of water is caused by the α, β and γ rays, and not by the direct action of Ra and its products, as Ramsay has suggested, was shown by placing a comparatively large amount of pure RaBr$_2$, contained in a sealed glass bulb, in a glass tube which was then immersed in a vessel of distilled water. The vessel was joined with a Hg

1909

manometer and completely exhausted of air. Although the
rays had to pass through a total thickness of glass of 0.5 mm.,
yet a regular increase in pressure was observed to take
place in the manometer, and continued to increase for
several months at a rate almost exactly proportional to the
time. The vol. of gas given off by the water, when thus ex-
posed to only the penetrating rays of Ra, amounted on an
average to 0.115 cc./day/g. of Ra. This amount is about 1%
of the vol. given off when the Ra is dissolved in the water.
But the energy of the rays passing through the glass in the
second experiment is only about 1% of the total energy. It
would thus seem that the amount of gas evolved in any case
is dependent upon the proportion of rays absorbed by the
water.

167   Duane, W. Compt. rend. 148, 1448, 1665(1909).
Heat evolution by Ra compounds.

168   Exner, F. "Ueber Radiumforschung." Vienna. (1909?).

169   Guye, P. A. and Druginin, G. "Formation of Active
Compounds by Curie's Method." J. chim. phys. 7,
97(1909).

170   Hahn, O. "On a New Product from the Activation
of Actinium." Physik. Z. 10, 81-8(1909).
A method for obtaining AcX (Ra^{223}) by recoil on a
negatively charged plate is described. It is also reported
that AcX is not volatile at red heat.

171   Hahn, O. and Meitner, L. "Typical β-radiation
from Radium Proper." Physik. Z. 10, 741-5
(1909).
A description of experiments carried out with the view of
ascertaining whether Ra itself sends out any β-radiation. A
full account of the method of preparing the substances used
is given, and the results are shown graphically. The general
results of the work are as follows: The β-rays from Ra
preparations do not originate, as has up to the present been
accepted, solely from RaB, RaC, and RaE$_2$, but Ra itself
gives out a typical β-radiation. This radiation can be
distinguished with absolute certainty from the other β-
radiations by its penetrating powers. One half of these β-
rays are absorbed by 0.00222 cm. of aluminium, so that
they possess an absorption coefficient represented by $\lambda = 312$
cm.$^{-1}$. According to the hypothesis put forward by the authors,
that complex rays correspond to complex substances, Ra
must be now considered as a complex substance because of
the presence of this β-radiation.

172   Keetmann, B. Jahrb. Radioakt. u. Elektronik 6,
265(1909).
An estimate of the half-life of Ra is given.

173   Kernbaum, M. "The Chemical Action of the Pene-
trating Rays of Radium on Water." Compt. rend.
148, 705-6(1909).
It is shown that the gas given off when the penetrating rays
from Ra act upon distilled water across glass in the manner
referred to by Debierne "The Decomposition of Water by the
Salts of Radium." Compt. rend. 148, 703-5, consists almost
exclusively of H, while H$_2$O$_2$ is formed at the same time in
solution.

1909

174   Landin, I. Swedish Pat. 31,711 (1909).
Substances containing radium are prepared by pulverizing
Ra-contg. material, sliming it, and treating the resulting
soln. with Ba fluosilicate.

175   Ramsauer, C. and Caan, A. "Radium Excretion in
Urine." München. med. Wochschr. 47, 1445-8(1909?).
The results of the investigation of the excretion of Ra in
the urine of clinical cases are tabulated. These show that
the radioactive substances are eliminated by the body in a
few years. The longest period noted for the complete
elimination was 3 yrs. in one case. Radioactive substances
are found in the urine.

176   Ramsay, W. "Apparent Decay of Radium." Nature
79, 129(1909).
Four small bulbs containing 172 mg. of Ra salts in so-
lution were sealed to a small Töpler pump, and the mixed O
and H gases formed were pumped off at intervals of 4 days
for a period of three years. With the emanation accompanying
the mixture of gases various experiments were performed,
the results of which have already been published. An additional
0.388 g. of pure RaBr$_2$ was then washed into a small bulb and
sealed to the pump along with the other bulbs. The electrolytic
gas now pumped off amounted to 30 cc. per week. This regular
evolution continued from Feb. until Nov. 11th. On Nov. 18th
the gas was pumped off again and amounted only to 13 cc. A
week later only 1.5 cc. were obtained, and the following week
0.5 cc. It is pointed out that either the RaBr$_2$ has ceased to
decompose water, or the reverse reaction, viz., the velocity
of combination of H and O to form water, has increased to
such an extent as to reverse the decomposition. It would
thus appear that one of the ways in which Ra expends at
least a portion of its energy has been stopped.

177   Soddy, F. The Interpretation of Radium. N. Y.,
Putnam. 1909. 256p.

178   Stock, A. and Heynemann, H. "The Volatility of the
Bromides of Radium, Barium, Strontium and
Calcium." Ber. 42, 4088-93(1909).
An attempt to sep. BaBr$_2$ and RaBr$_2$ by fractional subli-
mation. The authors used electrically heated quartz tubes
as containers for the compds. experimented upon, and exps.
were carried on under a pressure of 0.02 mm., attained by
a Hg pump. CaBr$_2$ sublimes at about 720°, SrBr$_2$ 770° and
BaBr$_2$ 820°. RaBr$_2$ sublimes 900°. Three sets of exps. were
made in the attempt to separate RaBr$_2$ and BaBr$_2$. In each,
a part of the salt used was retained as a control experiment;
the Ra content was detd. in two sublimates in exps. 1 and 2
and in one sublimate in exp. 3; it was detd. in the residues
in all 3 exps. In all cases, the Ra content was detd. by means
of an electroscope previously calibrated by using a Ra soln.
of known content. Results show that RaBr$_2$ is more difficult
to volatilize than BaBr$_2$ and that by partial sublimation the
residue is enriched in its Ra content; the less the sublimate,
the greater the difference in Ra content of the sublimate
residue. Authors express the hope that other investigators
having larger amts. of material at hand will pursue the
exps. with other Ra compds. and if possible get pure Ra
salts.

1909

179   Stomholm, D. and Svedberg, T.   Z. anorg. Chem.
       61, 341(1909).
Various methods for the precipitation and adsorption of
ThX(Ra^{224}) are described.

180   von Schweidler, E. and Hess, V. F.   Sitzber. math.-
       naturw. Klasse Akad. Wiss. Wien 117, 879(1909).
The authors report that 1 g. of Ra generates about 118
cal./hr.

181   Ulzer, F. et al.   British Pat. 19,820 (1909).
In obtaining radium salts or compds. and substances
contg. large proportions of Ra, the Ra-contg. materials are
first treated with conc. H_2SO_4 for a shorter time at normal
temp., or melted with bisulfates, and the residue remaining
after washing is melted with carbonates of alkalies or caustic
alkalies or mixts. of the same, or boiled with other conc.
H_2O solns. under pressure, or the order of stages may be
reversed in such manner that the treatment with the acid
agents follows the treatment with alkaline agents.

182   von Welsbach, I. C. A.   "Chemical Investigation of
       the Residues from the Preparation of Radium which
       Contain Actinium."   Z. anorg. Chem. 69, 353-91
       (1909).
1800 kg. of the hydrates obtained by the pptn. with NH_3 of
the HCl exts. (Debierne process for the prep. of Ra) from
10 tons of pitchblende residues, were given to the author by
the Radium Commission of the Imperial Academy of Sciences
to det. the chem. nature of the radioactive substances con-
tained and, if possible, to isolate these. A qual. exam.
showed the main constituents to be iron, alumina, lime,
rare earths, bismuth, uranium, silica and many other
elements in smaller quantities. Two general methods were
used. The "sulfate" method, which while complicated gave
more insight into the chem. relations, and permitted the
prep. of radioactive products in part without the use of
ignitions. The "oxalate" method was worked out on the
basis of results obtained in working up 120 kg. of the paste
by the "sulfate" method. Aside from polonium (RaF) there
was present ionium and actinium. The former seemed
homogeneous whereas the latter seemed complex. Ionium
follows the reactions of thorium, while actinium comes be-
tween lanthanum and calcium. Thorium salts containing
about 2½% of ionium were prepared — data as to the content
of actinium preps. are not yet available. The author says
that many observations lead him to believe that ionium can
cause chemically related substances to become radioactive
on long-continued action.

183   Watts, W. M.   "Calculation of the Atomic Weight
       of Radium from Spectroscopic Data."   Phil. Mag.
       (6), 18, 411-16(1909).
Runge and Precht, by comparing the wave-lengths of
corresponding lines in the spectra of Mg, Ca, Sr, Ba, and
Ra with the atomic weights, calculated the atomic weight of
Ra to be 257.8. This relation the author points out is not
linear as assumed by Runge and Precht. The lines repre-
senting the above relation are slightly curved, and the author
now gives the curves for four families, and has calculated
an interpolation formula which gives the atomic weights as
follows: Mg, 24.32; Ca, 40.08; Sr, 87.62; Ba, 137.41; Ra,
226.56. This shows that the spectroscopic data are quite con-

1909

sistent with the atomic weight found for Ra by chemical
methods.

1910

184   Curie, M. and Debierne, A.   "Metallic Radium."
       Compt. rend. 151, 523-5(1910).
For the preparation of metallic Ra the authors used the
method employed by Guntz in the prep. of metallic Ba
(Compt. rend. 133, 872; 141, 1240). The principle of the
method consisted in preparing the amalgam after which the
Hg was driven off by distillation. The amalgam was obtained
by electrolyzing a soln. containing 0.106 g. of pure $RaCl_2$
with a Hg cathode and Pt-Ir anode. When the electrolysis
was stopped 0.0085 g. of salt still remained in soln. The
amalgam which was entirely liquid was dried and quickly
transferred to an iron boat previously reduced in pure H.
The boat was placed in a quartz tube which was then im-
mediately exhaused and replaced by an atm. of pure H. By
keeping the pressure of H always greater than the pressure
of the vapor of Hg at the temp. of the boat the Hg was
distilled off below the b.p. of the amalgam and in this way
loss of material by spurting was guarded against. The
distillation was stopped at a temp. of 700° at which temp.
the distillation of Hg was complete and the metal remaining
behind likewise began to volatilize and strongly attack the
walls of the quartz tube. The metal which was shown to be
practically pure Ra was of a brilliant white color but rapidly
became black on exposure to the air, due it is supposed to
formation of nitride. Some particles of the metal having
fallen on a piece of white paper produced a blackening
similar to a burn. Radium decomposes water very
energetically and dissolves for the most part, showing that
the hydroxide is soluble. The dark residue which remained
and which was supposed to be the nitride readily dissolved
in dilute HCl. Preliminary radioactive measurements indi-
cated that the increase in activity followed the usual law for
the production of Em. and that the final activity of the metal
would be normal. Since it was found that metallic Ra is much
more volatile than Ba, it is proposed to purify it by subli-
mation in vacuo.

185   Curie, M.   "Estimation of Radium by Measurement
       of the Emanation Evolved."   Radium, Le 7, 65-70
       (1910).
The methods used for several years by the author to
measure small quantities of Ra, which are based on the
principle commonly adopted, are described in detail. Most
concordant results indicating an accuracy of 0.5% are ob-
tained when the emanation has accumulated for from 15 to
48 hours. A few hours accumulation gives, naturally, a less
definite result; periods of several days less concordant re-
sults are also obtained. The amount of emanation in this
case is generally too small, due perhaps to occlusion by the
glass containing vessel. Standard solns. have been prepared,
starting with the pure $RaCl_2$ used in 1907 to measure the at.
wt. of Ra. In dilution great care must be exercised as
regards cleanliness of containing vessels, and purity of
reagents, to prevent pptn. of Ra. Even with greatest care
a small percentage of Ra in these standards is lost in time
probably by absorption by the glass. Secondary standards
are improved by addition of Ba salts. The saturation cur-
rent from the equilibrium amt. of emanation from 1 g. Ra

1910

is 3.5×10^5 e.s.u., for a cylindrical ionization chamber, 6.7 cm. in diam., 12.5 cm. high, and 440 cc. capacity, with an axial wire electrode 3 mm. thick and charged to 800 volts. A series of results show some divergence. The amount of emanation from freshly cryst. $RaCl_2$ shows a slight increase with time, while solns. from which the Ra has been pptd. by H_2SO_4 show progressive diminution. These facts suggest the existence of an element intermediate between Ra and the emanation (RaX).

186   Dewar, J. "Long-Period Determination of the Rate of Production of Helium from Radium." Proc. Roy. Soc. (London) A 83, 404-08(1910).

In a previous research the rate of the production of helium from 70 mg. of radium chloride was determined by a succession of observations on the growth of pressure measured by a McLeod gauge, the observations extending over 6 weeks. It was thought desirable to make an experiment to determine the amount of He resulting from this same sample of radium, after standing in a sealed bulb for an extended period. For this purpose the bulb containing the radium chloride was sealed off at the conclusion of the above-mentioned experiment of 1908 and kept for 9 months. In order to measure the He thus produced it was necessary to devise a vacuum-tight joint between the sealed radium bulb and a McLeod gauge so constructed that, after thoroughly exhausting the gauge, the drawn-out end of the radium bulb could be broken off, thus allowing the pressure of the accumulated He in the radium bulb to be rapidly determined. This is described by aid of a figure. The capillary sealed-up part of the bulb had a file mark on it and could be rocked from the outside so as to be snapped off by pressure against a neighboring protuberance. The data of the experiment show that a corrected pressure of 0.01613 mm. in a volume of 320 cm.^{3} was due to the He produced from 70 mg. of pure radium chloride during a period of 275 days. It is hence deduced that the rate of production of He is 0.463 mm.^{3}/g. Ra/day. In the 1908 paper the rate of production was given as 0.37, but on again examining the apparatus it was discovered that the volume of that gauge and apparatus then used was 270 cm.^{3}, and not 200 cm.^{3} as formerly supposed. The previous value is thus corrected to 0.499 mm.^{3} of helium/g. Ra/day, which is in good agreement with the present determination. Indeed, the author thinks the true value may lie between these two results 0.463 and 0.499.

187   Dominici, H. and Faure-Beaulieu, M. "The Arrest and the Prolonged Stay of Radium in the Living Tissues for a Period Exceeding a Year." Compt. rend. soc. biol. 68, 46-8(1910).

A rabbit killed 18 mos. after 0.05 mg. of $RaSO_4$ had been injected into his ear showed no morbid manifestations. After incineration the lungs, kidneys, spleen, liver and brain were found to contain Ra. A second rabbit killed 14 mos. after 0.02 mg. of $RaSO_4$ had been injected into the veins showed no radioactivity in any of the organs.

188   Dominici, H., Petit, G., and Jaboin, A. "The Existence and Applications of Radioactivity Persisting in the Organism after Intravenous Injection of an Insoluble Salt of Radium." Compt. rend. 150, 726-8 (1910).

1910

1 mg. of insol. $RaSO_4$ was injected into the jugular vein of a horse. The injection was followed by a regularly decreasing Ra elimination in the urine, which could not be detected after 4-5 mos. A large portion of the Ra remained in the animal, and Ra could still be measured in the blood after 6 mos. The horse was not injured by the injection, but gained considerable wt. during the succeeding mos. The authors suggest that the injection of insol. Ra salts may be of therapeutic value.

189   Duane, W. "The Energy of the Radium Rays." Compt. rend. 151, 471-3(1910).

Five methods were tried with a view to detg. the energy of the Ra rays. A bolometer, a radiometer and a thermopile did not give good results, but positive results were obtained with a differential gas thermometer and a sensitive calorimeter. Details are given of the app. employed in the last case. Judging from the preliminary expts. it is hoped to obtain by this method a good measurement of the energy of the α-rays the whole length of their range, and also of the β and γ-rays providing this is not less than 1/100 of the total energy of the α-rays.

190   Ebler, E. "The Preparation of Metallic Radium." Ber. 43, 2613-18(1910).

The method employed in the prep. of metallic Ra consisted in preparing $Ra(N_3)_2$ which on heating in a vacuum decomposed into the metal and N. In preparing the azoimide, a soln. of 1 mg. of Ra — Ba bromide containing 9% $RaBr_2$ was treated with $(NH_4)_2CO_3$. The ppt. was filtered off in a micro-filtering app. and dissolved in HN_3. The soln. was evapd. to dryness and carefully dried to constant wt. in a vacuum over H_2SO_4. The dry salt was then transferred to a small melting pt. tube which was in turn placed in a larger tube and exhausted with a Hg pump. On heating the tube with its contents for several hrs. at a temp. of 180-250°, about 73% of the Ra mixed with the Ba was converted into the metallic form and appeared as a shining metal surface. It is thus shown that Ra is a metal analogous to Ba and not a radical like NH_4^+, and was found, from measurements made of the γ-rays, to lose none of its properties in the metallic state. Attention is called to the importance in this expt. of having the azoimide perfectly dry before being heated for otherwise the metal cannot be obtained in a bright metallic state. Preliminary expts. showed that $Ba(NO_3)_2$ is not decomposed by Ra rays.

191   Eve, A. S. and McIntosh, D. "The Influence of Acids and Salts on the Amount of Emanation Liberated from a Solution of Radium." Trans. Roy. Soc. Can. III 4, 66-8(1910).

Ba salts reported to be chemically pure were tested for their Ra content. The results are expressed in 10^{-12} g. Ra/g. salt: $BaCl_2$, 2.84; $Ba(OH)_2$, 0.11; $Ba(NO_2)_2$, 0.36. These substances contain therefore about as much Ra as many rocks or soils, and great care is necessary in measuring minute quantities of Ra in the event of chem. treatment with a Ba salt. Certain ppts. appear to occlude Ra and in that way to check the escape of Rn. Thus a soln. of $RaBr_2$ in 220 cc. water, containing a trace of HCl, liberated 100% Rn, while another to which 10 cc. 10% $BaCl_2$ and 1 cc. H_2SO_4 were added liberated only 13%.

1910

192   Kolowrat, L. "β-Rays from Radium." Radium, Le 7, 269-75(1910).

Hahn and Meitner have found that a radium salt freed from its emanation and active deposit, emits a very absorbable β-radiation. The author has repeated these experiments and obtained results showing a general agreement with them. In the experiments a piece of Pt-foil, containing a little Ra, was heated for several hours to drive off the emanation and active deposit, a thin sheet of Al being then fixed hermetically over it. The intensity and absorbability of the radiation given off was then observed both initially and at subsequent intervals. From these observations it is calculated that a radiation arises from Ra itself, its intensity being about 2 per cent of the equilibrium β-ray intensity and its absorbability of the order 200 cm^{-1}. Allowance had to be made for a small initial amount of RaEm which it was impossible to get rid of.

193   Kolowrat, L. "The Beta Rays of Radium at its Minimum Activity." Compt. rend. 151, 525-8(1910).

Hahn and Meitner found that any material containing Ra still emits β-rays of small penetrating power after the Em. and active deposits have been removed by heating, or in a chemical way, and that this radiation amts. to about 7% of the total β-radiation when the Ra is in radioactive equilibrium. With a different arrangement the author was able to verify these results with the exception that the intensity of the rays was found to be only 2% of the β-radiation corresponding to the equilibrium amt. The method employed consisted in heating a small amt. of a salt of Ra on a sheet of Pt after which the activity was detd. at intervals with a series of Al screens of variable thicknesses interposed above the Ra at each set of measurements. When a soln. containing about 0.5 mg. of pure RaCl$_2$ was evapd. on a Pt sheet it was found impossible to drive off all the Em. by heating, even when placed in an electric furnace at a temp. of 1320°. With a chloride, or bromide, salt of Ba containing about 1% of Ra this difficulty was not met with. The coef. of absorption, μ, of the β-radiation is of the order of 200 cm.$^{-1}$ at first, but it decreases regularly and in several days finally reaches the fixed value of $\mu = 60$ cm.$^{-1}$. The rate at which μ decreases agrees with the theoretical value calculated on the assumption that the rays observed result from the combined effect of an activity which does not vary with time and which amts. to 2% of the equilibrium activity and having $\mu = 200$ cm.$^{-1}$ and of an activity with $\mu = 60$ cm.$^{-1}$ and proportional at each instant to the sum of the rates of decay of RaB and RaC.

194   Kolowrat, L. "Production of Emanation by Radium Salts." Radium, Le 7, 266-9(1910).

To represent the production of Em. by a salt containing Ra, time is plotted as abscissas, measured from the moment in which the salt has lost all its Em. by being melted, while the quantities of Em. which remain absorbed in the salt are plotted as ordinates. Making the quantity per hr. equal to unity, the amt. absorbed at any instant, t, is represented by $(1 - e^{\lambda t})/\lambda$, if there is no production of Em. which is true for ordinary temp. If there is a production of some temp., θ, the absorbed quantity is expressed by $c(1 - e^{\lambda t})/\lambda$, in which c is a coeff. between 0 and 1, depending on θ but independent of t. In general, expts. made at the same temp. but at different times give fairly concordant values of c, even though

1910

the salt has been fused between 2 attempts. However, values differ when obtained with the same salt, from different trials which have been carried on in presumably the same way but not under the same conditions from the start. Since the discrepancies might possibly be due to the presence of impurities, expts. on the production of Em. were made at a const. temp., 606°, with a number of samples of Ra-containing BaCl$_2$. With an impure salt, lower values for c, and, hence, a greater production of Em are obtained, at least in the beginning. The hypothesis of a solid soln. to explain the role of specific impurities cannot be drawn. Attempts were made to detn. whether there was any change if pure RaCl$_2$ was substituted for Ba salts of low Ra content. Accurate results were impossible since the small available amt. of RaCl$_2$ changed on heating, possibly with formation of oxide or oxychloride. It became insol. and apparently infusible. Even at about 300° the salt does not produce its total content of Em.

195   Kolowrat, L. "Slow Precipitation of Radium Sulfate." Radium, Le 7, 157-9(1910).

A dilute solution of RaCl$_2$ was treated with several drops of H$_2$SO$_4$ and filtered, and the filtrate placed in an emanation "bubbler". The rate of disengagement of emanation was measured and found to fall gradually to nearly half its original value in about a month, while on the application of heat the rate of release of emanation increased. The author explains this, and other experiments described in the paper, by assuming that the RaSO$_4$ remains partly in solution but gradually becomes precipitated and no longer gives up its emanation. Under the action of heat, part of the precipitate redissolves and gives off the whole of the emanation accumulated since its precipitation.

196   Landin, J. Swedish Pat. 32,575 (1910).

Modification of the treatment of radium-containing substances, extn. with acid after conversion into a salt insol. in H$_2$O in which a sol. Ba, Ca, Sr, or Pb salt is dissolved, in order to ppt. out those acid radicals which would otherwise interfere or prevent the soln. of the Ra in the acid.

197   Landin, J. Swiss Pat. 34,200 (1910).

In the preparation of radium sulfate, the material containing Ra is treated with conc. or fuming H$_2$SO$_4$, and the product is either dild. or heated to obtain the sulfate.

198   Lloyd, S. J. "The Estimation of Radium." J. Phys. Chem. 14, 476-81(1910).

The effect of foreign substances upon the amt. of RaEm extracted from a Ra soln. was examined. BaSO$_4$ freshly pptd. in the soln. greatly lessened the amt., as did BaCO$_3$ and carbonates in general. Pptn. of insol. chlorides, oxides, chromates, etc., lessened the amt. not more than 5%. Repeated extraction of the Em from a soln. which had been pptd with BaSO$_4$ gave amts. which increased until the correct one was reached. To obtain accurate results in estimating Ra by the extraction of its Em, HCl or HNO$_3$ must be added, and if BaSO$_4$ is also present, repeated detns. made until a constant maximum is reached.

199   Marckwald, W. "Mesothorium." Ber. 43, 3420-2 (1910).

1910

As the properties of mesothorium are very similar to those of Ra which has 300 times as long a life, great care must be taken not to confuse the two. To test a Ra prep. for the latter, heat it a short time, to drive out the emanation; in a few hours it will lose its power of emitting γ-rays, which it regains in the course of several weeks. Instead of heating, the compd. may be dissolved in H_2O; the soln. is evaporated and all the RaEm is driven out. If any γ-rays remain behind, they come from the mesothorium. The ratio of the γ-rays before and after this treatment is a measure of the amts. of Ra and mesothorium present.

200   Petterson, H. Arkiv Mat. Astron. Fysik 6, 26(1910).
   The author reports that 1 g. Ra generates about 116.4 cal./hr.

201   Rutherford, E. and Boltwood, B. B. "Production of Helium by Radium." Mem. Proc. Manchester Lit. & Phil. Soc. 54, No. 1, 1-2(1909-1910).
   A Ba-Ra salt containing about 200 mg. of Ra, from which Po and RaD had been removed chemically, was placed in a Pt capsule which was in turn sealed in an exhausted tube of hard glass. At the end of 83 days, the gases were completely removed by heating and exposed to charcoal cooled in liquid air. The unabsorbed gases were pumped out and repeatedly exposed to fresh cooled charcoal. The residual gas consisting of essentially pure He had a volume corresponding to the production of He at the rate of 163 mm.^{3}/g. Ra/year, a value somewhat higher than that found by Dewar of 135 mm.^{3}/g./year, but close to the quantity, 158 mm.^{3}, calculated by Rutherford and Geiger from their experiments on counting the α-particles.

202   Rutherford, E. and Geiger, H. "The Charge and Nature of the Alpha Particle." Proc. Roy. Soc. (London) 81A, 162-73(1910).
   Additional data on Ra presented: 0.585 mm.^{3} Rn produced/g. Ra/yr.; 113 cal./hr./g. Ra heating effect; life of Ra = 1760 yr.

203   von Welsbach, I. C. A. "Chemical Investigation of the Residues from the Preparation of Radium which Contain Actinium." Monatsh. 31, 1159-1202(1910).
   1800 kg. of the hydrates obtained by the pptn. with NH_3 of the HCl exts. (Debierne process for the prep. of Ra) from 10 tons of pitchblende residues, were given to the author by the Radium Commission of the Imperial Academy of Sciences to det. the chem. nature of the radioactive substances contained and, if possible, to isolate these. A qual. exam. showed the main constituents to be iron, alumina, lime, rare earths, bismuth, uranium, silica and many other elements in smaller quantities. Two general methods were used. The "sulfate" method, which while complicated gave more insight into the chem. relations, and permitted the the prep. of radioactive products in part without the use of ignitions. The "oxalate" method was worked out on the basis of results obtained in working up 120 kg. of the paste by the "sulfate" method. Aside from polonium (RaF) there was present ionium and actinium. The former seemed homogeneous whereas the latter seemed complex. Ionium follows the reactions of thorium, while actinium comes between lanthanum and calcium. Thorium salts containing about 2-1/2% of ionium were prepared - data as to the con-

1910

tent of actinium preps. are not yet available. The author says that many observations lead him to believe that ionium can cause chemically related substances to become radioactive on long-continued action.

1911

204   Bleecker, W. F. (to the Standard Chemical Company) U. S. Pat. 1,065,581 (1911).
   A method for leaching carnotite first with alkali, then with acid.

205   Boltwood, B. B. and Rutherford, E. "Production of Helium by Radium." Phil. Mag. (6), 22, 586-604 (1911).
   The rate of production of He by a Ra salt (containing 0.193 g. Ra) was measured accurately, and found to be equal to 0.107 mm.^{3} He/day/g. Ra (element), which is equiv. to 156 mm.^{3} He/yr./g. Ra in equil. with its first disintegration products, the Em., RaA, and RaC. This shows good agreement with the figure previously found by Dewar working with only 0.07 g. Ra, and which, corrected to the authors' Ra standard is 164 mm.^{3} The rate of production found is in excellent agreement with the figure 158/mm.^{3} He/yr., calc. by Rutherford and Geiger from the results of their expts. on the number of α-particles emitted by Ra. The amt. of He formed in 21 days from the volume of RaEm in equil. with 0.126 g. Ra was measured and found to be 0.202 mm.^{3} The theoretical amt. is 0.220 mm.^{3}, in fair agreement. The production of He from Po, and from a prep. containing radio-lead (and therefore RaE, and Po) was observed.

206   Boltwood, B. B. and Rutherford, E. "Production of Helium by Radium." Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 120, 2a, 313-36(1911).
   The authors have made an extended determination of the volume of He produced from a large quantity of Ra, and found it to correspond to approximately 156 mm./year/g. Ra in equilibrium with its disintegration products to RaC. This observed rate of production of He is in close agreement with the rate calculated from the counting experiments of Rutherford and Geiger (158 mm.^{3}/yr.), thus proving that the α-particle, during its flight, consists of a He atom carrying two unit positive charges and that He itself is monatomic. The authors point out that agreement of the observed and calculated values is independent of the purity of the Ra-standard employed, as the same standard has been used in both measurements.

207   Curie, P. "Die Entdeckung des Radiums." Leipzig, Akad. Verlagsgesellschaft. 1911 (?).

208   Danysz, J. "The Beta Rays of the Radium Group." Compt. rend. 153, 339-41(1911).
   An investigation was made on the comp. of the β-rays from the Ra group by adopting under improved conditions the method first used by Becquerel which consisted in photographing the trajectories of the rays when acted upon by a magnetic field. The source of the rays consisted of RaEm, from 0.12 g. $RaCl_2$, which was condensed in a small glass tube with walls only 0.04 mm. in thickness. In this way the interference of secondary rays was avoided. The magnetic

spectrum obtained showed the existence of seven distinct homogeneous beams of rays. The velocity of the different rays were calculated to be approx., 0.98, 0.95, 0.86, 0.81, 0.75, 0.69, and 0.63, the velocity of light being taken as unity.

209   Dominici, H., Petit, G. and Jaboin, A. "Persisting Radioactivity of the Organism under the Influence of Injection of Insoluble Radium Compounds. Radioactive Serotherapy." Compt. rend. 153, 1509-11(1911).
One yr. after the injection of 1 mg. $RaSO_4$ into a horse the serum of this animal was still radioactive. This radioactive serum possesses therapeutic properties and is of service in the treatment of cancer and infectious diseases.

210   Ebler, E. "Fractional Adsorption of Radium-Barium Salts and Fractional Electrodialysis of the Resulting Adsorption Compounds." Orig. Com. 8th Intern. Congr. Appl. Chem. 2, 91-3(1911?).
Freshly pptd. $Fe(OH)_3$ in 20% gelatin-gel-acetylcellulose adsorbs Ra salts less than does silicic acid. Manganese dioxide hydrate shows high adsorbing power for nearly all Ra salts. Basic Fe carbonate shows strong adsorptive power for $RaCO_3$. Boiling with dil. HCl splits the adsorption compd. into $RaCl_2$ and a sol. $Fe(OH)_2Cl$ which are readily sepd., best by electrodialysis using a Hg cathode. By measuring the α-radiation of evapd. portions of the cathode liquid and change of the cathode solns., fractions can be obtained as desired. The Ra-Ba-adsorption compds. with MnO_2 and SiO_2 need not be changed to the sol. condition before dialysis.

211   Ebler, E. Z. anal. Chem. 50, 611(1911).
In the reduction of crude sulfates $PbSO_4$ can be removed without loss of Ra using a hot solution of NH_4NO_3.

212   Ebler, E. German Pat. 243,736 (1911).
In the manuf., isolation, and enrichment of substances contg. radium and the like, certain colloidal substances (gelatin) are employed as absorbents for radioactive substances, being sepd. from the material from which the active substance is absorbed, and then driving off the colloidal substance, as by burning, volatilizing as haloid, sulfide, or ester or otherwise, the radioactive substances remaining in a concd. state.

213   Ebler, E. and Fellner, M. "The Concentration and Isolation of Radioactive Substances by Fractional Adsorption." Ber. 44, 2332-8(1911).
Using very pure metasilicic acid, Ra, RaEm, RaD, RaE, RaF, and UX were adsorbed from their solns. Adsn. achieved by shaking solns. containing radioactive material with silicic acid. Acid then sepd. by filtering or centrifuging. A comparison of the activity in filtrate and residue shows a concentration factor much higher than that obtained by pptn. or crystallization.

214   Exner, F. and Haschek, E. Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 120, 2a, 967(1911).
The arc spectrum of Ra is described.

215   Geiger, H. and Nuttall, J. M. Phil. Mag. (6), 22, 613(1911).

Range, velocity, momentum, and kinetic energy of the alpha particles of Ra are discussed.

216   Hahn, O. and Meitner, L. Phys. Zeit. 10, 741(1911).
The absorption coefficient of the β-rays of Ra was found to be 200 cm.$^{-1}$ Al.

217   Haitinger, L., Peters, K., and Meyer, S. "Radium and Mesothorium in Monazite Sand." Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 120, 2a, 1199-1204 (1911).
A preparation of radium extracted in 1904 from monazite sand has been examined in the light of recent researches to find if mesothorium also is present, and it was found that the preparation consists chiefly of mesothorium with only a very small quantity of radium. The authors find that the mesothorium is similar to barium in its chemical properties, separation, however, being effected by fractionation of the chlorides. It cannot be separated from radium. A simple method of separating radiothorium from mesothorium is given. It is found that the bromides of radium and mesothorium are very soluble in water and can be separated from the insoluble radiothorium by decantation.

218   Herschfinkel, H. "Attempts to Prepare Metallic Radium." Radium, Le 8, 299-301(1911).
Repetition of Ebler's work attempting to obtain metallic Ra by heating Ra-Ba hydrazoate in vacuo (1 mg. Ra in 11 mg. substance). Decomp. took place, with production of small quantities of N, and very impure metal which may have contained a little Ra. It seems likely that Ra hydrazoate cannot be prepared, since the radiations would decompose it as fast as it was formed.

219   Hönigschmid, O. "Revision of the Atomic Weight of Radium." Sitzber. Math.-naturw. Klasse Wiss. Wien 120, 2a, 1617-52(1911).
Six detns. were made to ascertain the ratio $RaCl_2/AgCl$. In all 6.06756 g. of $RaCl_2$ were used, which yielded 5.85933 g. AgCl, when the ratio $RaCl_2/AgCl$ is 1.03554, and the at. wt. of Ra, assuming 107.88 for Ag, has the value 225.95 ± 02. The specimens of $RaCl_2$ used in the final expts. were purified by repeated crystns. from aq. solns. followed by crystn. from conc. HCl soln. The progress of the purifications was followed by chem. analysis, finding the ratio $RaCl_2/AgCl$. The various refinements introduced by T. W. Richards for at. wt. detns. were carefully followed throughout the work. The samples of $RaCl_2$ used were fused in an atm. of HCl to render them anhydrous. A specimen of $RaCl_2$ of 0.57579 g., dehydrated in a current of air at 200 for 45 min., gave a value of 225.93 for the at. wt. of Ra.

220   Hönigschmid, O. Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 120, 2a, 1661(1911).
The author reports the melting point of $RaCl_2$ to be about 900°.

221   Kolowrat, L. "An Attempt to Measure the Electric Conductivity of Radium." Radium, Le 8, 401-4(1911).
In 3 expts. 20, 125 and 120 millicuries of Rn resp. were forced into a narrow capillary tube of glass after being freed as far as possible from all traces of other gases,

especially O. The capillary was furnished with 2 Pt wires of almost the same diameter entering the glass a few mm. apart, and in the first 2 expts., in order to insure good contact, the interior of the glass was silvered except between the Pt terminals. With a layer of Pb of the same thickness as that to be expected for the RaD, the resistance should be about 40 ohms. The resistance was always greater than 10^6 ohms showing that no continuous deposit of metal had been formed. The Ag slowly disappeared, showing apparently minute residual traces of O, and to the same cause is attributed the nonappearance of metallic RaD in the quantity expected. In the first expt., after 3 or 4 days, a brown ring appeared about midway between the electrodes, about a mm. in length, and giving a metallic reflection. It remained constant for 3 days and then slowly disappeared; heating did not cause it to reappear. The explanation suggested is that the RaD was deposited metallically after most of the O had combined with the Ag, while the last traces of O slowly oxidized it and so caused it to disappear. A somewhat similar appearance was obtained in the 3rd expt. where other elaborate precautions were taken to get rid of last traces of O.

222   Laborde, A. Méthodes de mesure employées en radioactivité. Paris. 1911.

223   Marchwald, W. Ber. 44, 772(1911).
An article on the leaching of pitchblende with H_2SO_4 and HNO_3, and the extraction of $RaSO_4$ with alkali.

224   Meyer, S. and Hess, V. F. "The Attainment of the Saturation Values with Ionization through Alpha Rays." Chem. Ztg. 35, 937(1911).
Curves and tables for polonium, Ra and ionium are given, from which the satn. values of current can be ascertained, if, as is the case with strong preps., satn. is not reached by use of high potential.

225   Navrat, V. and Haschek, E. "The Arc and Spark Spectra of Radium." Chem. Ztg. 35, 842(1911).
The spectrum obtained by Runge and Precht and considered as a spark spectrum was in reality the arc spectrum.

226   Pusey, W. A. "Biological Effects of Radium." Science 33, 1001-5(1911).
A review.

227   Radcliffe, S. U. S. Pat. 1,049,145 (1911).
A method of fusing carnotite with $NaHSO_4$ for U recovery.

228   Radcliffe, S. British Pat. 8,936 (1911).
A method for the extraction of Ra from earths poor in Ra using $NaHSO_4$.

229   Radcliffe, S. German Pat. 32,950 (1911).
Fusing of radium ore with NaCl and $NaHSO_4$ used for Ra recovery.

230   Smith, E. B. "Distribution and Excretion of Radium and Its Emanation after Internal Administration." Quart. J. Med. (1), 5, 250-63(1911?).
After the administration of Ra by mouth or by injection, a wide-spread degree of radioactivity is evident throughout

the body. Elimination of Ra takes place principally and rapidly by the bowel, in a lesser and slower degree by the kidneys, and by the liver and skin not at all. There is an active excretion by the small intestine, and also probably by the colon. In the lungs there is at all times, after inoculation, the presence of the Em., possibly due to the extreme vascularity of these organs. The duration of the activity in the body, or the time taken in excretion, differs with regard to the nature of the prep. used. Sol. salts, however administered, are rapidly eliminated. The insol. salts, per os, are excreted directly by the bowel, and there is no evidence of any absorption and circulation. When given by injection, however, an exceedingly slow elimination occurs by the bowel.

231   Soddy, F. The Chemistry of the Radio-Elements. N. Y., Longmans. 1911(?).

232   Soddy, F. U. S. Pat. 1,031,593 (1911).
A method for the extraction of $MsTh_1$, (Ra^{228}) from monazite sand is given.

233   von Baeyer, O., Hahn, O., and Meitner, L. "Magnetic Spectra of the β-rays of Radium." Physik. Z. 12, 1099-1101.
The magnetic spectrum of the β-rays from the short lived active deposit of Ra was photographed. The negatives revealed a discontinuous spectrum consisting of 9 lines, 4 of which belong to RaC, with velocities between 0.8 and 0.98 that of light; the remaining 5 lines belong to RaB, and have velocities between 0.36 and 0.74 that of light. Ra itself emits 2 β-rays whose velocities are approx. 0.65 and 0.52 that of light.

234   Curie, M. Die Radioaktivitat. (tr. by B. Finkelstein) Leipzig, Akademische Verlagsgesellschaft m.b.H. 1912.
Volume I contains a large amount of information on the compounds of radium and their properties. The halides and nitrates of radium are particularly well treated.

235   Curie, M. "International Radium Standard." J. Phys. (5), 2, 795-826(1912).
The paper contains an account of the methods of comparing quantities of radium, particularly the γ-ray method. An ionization chamber or γ-ray electroscope is recommended with lead walls at least 5 mm. thick. For correction, if the radium samples are not contained in the same vessels, μ for glass may be taken to be 0.1 cm.$^{-1}$, and for lead 0.5 cm.$^{-1}$. For glass vessels of 1/2 mm. thickness the absorption of the γ-rays is only about 0.5%. Correction may be necessary in some cases for the absorption of the γ-rays by the material itself. It is necessary that the radium samples should have been sealed up at least a month previous to measurement so that the equilibrium amount of emanation may have been produced. The international radium standard is next described. This was prepared by Mme. Curie from the material used in 1907 for the determination of the atomic weight of Ra, the value found being 226.5. Part of this radium was purified from RaD, E, and F, and weighed in the form of anhydrous $RaCl_2$, the weight being 0.02199 g.

1912

(RaCl$_2$). This was placed in a glass tube of wall thickness 0.27 mm. and diam. 0.9 mm., and sealed off in Oct., 1911, with a piece of thin Pt-wire also sealed into the tube. The standard was compared with that prepared by Hönigschmid (0.03117 gm. RaCl$_2$), and the two were found to have γ-ray activities corresponding to the weights to within 0.2%. The International Congress has therefore accepted the Curie radium preparation as the standard to be placed in the Bureau International des Poids et Mesures. It is pointed out that as the radium was prepared from Joachimstal pitchblende, which contains little Th, no appreciable disturbance can arise from mesothorium, which cannot be chemically separated from Ra.

236   de Mare, F. and Jacobs, C. "Alloys and Electrolytic Deposits of Radium." Bull. Acad. roy. sci. Belg. classe sci. 53-4(1912).
By reduction of Ra sulfate, AgCl, CaCO$_3$ and C in a silica crucible a radioactive Ag-Ra alloy of yellowish white color was obtained; the alloy is malleable and ductile. By electrolysis of Ra acetate with use of Pt electrodes a highly radioactive brown deposit was obtained on the cathode; this deposit renders a Ba cyanoplatinate screen phosphorescent and affects a photographic plate. By placing Ra acetate in a vessel and using a metal cover with an embedded quartz crystal, a photographic plate (the plate was wrapped in black paper when used in the light, but was not so protected when exposed in a dark room) being placed on the crystal, it was found that quartz is permeable in the luminous radiations, but not to the α, β, and γ radiations.

237   Ebler, E. German Pat. 276,071 (1912). (Addition to German Pat. 243,736)
Isolating and concentrating radium and other radioactive materials by adsorption, with the aid of MnO$_2$, from solns. containing Ba together with the radioactive materials are described.

238   Fischer, S. W. (to R. E. Booraem and C. R. Hill) U. S. Pat. 1,054,102 (1912).
A method for leaching carnotite with alkali-lye mixtures for Ra recovery.

239   Glaser, F. Chem. Ztg. 36, 1166-7(1912).
An article on the leaching of autunite with HCl and Na$_2$CO$_3$ for Ra recovery.

240   Haschek, E. and Hönigschmid, O. "International Radium Standard." Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 121, 2a, 2119-25(1912).
The authors have examined the Ba-content of the radium used by Hönigschmid in his determination of the atomic weight (value 225.95). The spectrum of the salt showed no Ba lines, and from observations of the amount of added Ba necessary to show the lines the authors conclude that the original salt did not contain more than 0.002% Ba.

241   Hess, V. F. "Heating Effect of Radium." Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 121, 2a, 1419-27(1912).
The author has made measurements, using the radium purified by Hönigschmid and the apparatus of Meyer and

1912

Hess. The radium salt, 570.10 mg. RaCl$_2$, was crystallized from an acid solution, dried, and introduced into the calorimeter, and the rise of the heating effect observed over a period of several days. The observations were found to agree well with the theoretical formula $Q_t = Q_{Ra} + Q_E(1-e^{-\lambda t})$, where Q_t, Q_{Ra}, and Q_E are the heat evolution of the whole, the radium itself and the emanation respectively and λ is the transformation constant of RaEm. The values deduced for Q_{Ra} and Q_E are 25.2 and 107.1 g. cal./hr. respectively, giving a total of 132.3. Q_E includes the products as far as RaC in their equilibrium amounts. In the experiments all the α and β-rays and 18% of the γ-rays were absorbed. Assuming that all the heating effect of the radium, without its products, is due to the kinetic energies of the α-particles and the recoil atoms the velocity of the former is deduced to be 1.595×10^9 cm./sec.

242   Hönigschmid, O. Monatsh. 33, 258(1912).
A method for obtaining chemically pure RaCl$_2$ as well as some properties of RaBr$_2$ and RaCl$_2$ are described.

243   Hönigschmid, O. Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 121, 2a, 1979-95(1912).
A method for obtaining chemically pure RaBr$_2$ is described as is the prepn. of RaSO$_4$ from other Ra salts by pptn. with H$_2$SO$_4$. The prepn. of dry RaCl$_2$ from RaBr$_2$ by heating in HCl stream is also described. It is reported that complete dehydration of RaBr$_2\cdot$2H$_2$O can be accomplished by heating in dry air stream at 200°, the color change upon dehydration is reported.

244   Jost, B. "Explosion of Radium Bromide." Chem. Ztg. 36, 138(1912).
Occasional explosions of specimens of RaBr$_2$ are attributed to gradual absorption of moisture resulting in a weakening of the forces of cohesion in the crystal to the point where the pressure of the accumulated emanation (He) suddenly ruptures the crystal.

245   Marckwald, W. "The International Radium Standard." Physik. Z. 13, 732-4(1912).
Discussion of Curie's and Hönigschmid's methods for showing purity of Ra (addn. of 0.6% Ba and note the strengthening of Ba spectrum lines, and recrystn. to constant at. wt., resp.) Claims results are not proof of purity but that the method of H. could be if another salt were formed and the atomic wt. confirmed with it. Discussion of at. wt. results.

246   Meyer, S. and Hess, V. F. "Vienna Standard Radium Preparations." Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 121, 2a, 603-31(1912).
The standard preparations consist of the RaCl$_2$ prepared by Hönigschmid in his determination of the atomic weight of Ra. The present paper deals with (1) the heat evolution; (2) the ionization due to the α-rays from a very thin film of the substance; (3) the ionization due to the γ-rays, and (4) the amount of emanation in equilibrium with the material. The heat evolution of 1 g. radium element in equilibrium with its products (emanation, RaA, B, and C) when all the α- and β-rays and 18% of the γ-rays were absorbed was found to be 132.26 g. cal./hour, or if all the γ-rays were absorbed 138 g. cal./hour. The calculated

value based on the ordinary results for the initial velocities of expulsion of α-rays is approximately the same as the experimental value. Different methods of determining the Ra-content of a preparation from its γ-ray ionization were tested, and data are given for various dispositions, by means of which an ordinary preparation of radium can be standardized without the necessity of comparing it directly with a standardized preparation. The measurements of the current produced by 1 cc. RaEm in a cylindrical chamber without subsequent products gave the value 2.7×10^8 e.s.u., which is in good agreement with the result of Flamm and Mache. From the thorium content of the residues from which the Ra was extracted, and the fact that ionium is separated out with Th, it was deduced that the period of average life of ionium cannot exceed about 200,000 years.

247   Radcliffe, S.   Chem. Ztg. Repert. 36, 537(1912).
     Experiments on the use of $NaHSO_4$ for the extraction of radium from earths poor in Ra are described.

248   Rutherford, E.   Radioactive Substances and Their Radiations.   Cambridge, Cambridge Univ. Press. 1912(?).

249   Rutherford, E. and Chadwick, G.   "A Method of Compensation for the Comparison of Quantities of Radium, and Some Applications of This Method." Radium, Le 9, 195-200(1912).
     The compensation method employed consists in the comparison of ionization produced in one ionization chamber by the γ-radiation from Ra preps. with that produced by a layer of U_3O_8 in a second chamber in which the electrode is in metallic communication with that in the first. By varying the distance of the Ra from the ionization chamber exact compensation is obtained and is verified by a Dolezalek electrometer. The first ionization chamber was covered by Pb of thickness either 3 mm. or 1 cm. It is shown that ionization in the first chamber varies according to the expressing $\dfrac{e^{-\mu r}}{r(r \pm a)}$, where μ is the coeff. of absorption of γ-rays by air, r is the distance of the Ra from the chamber, and a is the depth of the chamber to the electrode. This has been experimentally verified, with good agreement (1 in 400) at distances over 60 cm.; at smaller distances the error increases. An expression is given for the detn. of quantities of Em. Using the method the period of half decay of the Em has been found to be 3.854 days, in good agreement with preceding figures. The max. γ activity from the Em is attained after 255 minutes. No measurable effect on the emission of γ-rays was observed on placing a tube containing Em between the poles of a powerful electromaget.

250   Schmidt, H. W. and Nick, H.   "Experiments with Weak Radium Solutions."   Physik. Z. 13, 199-207 (1912).
     Standard solns. of Ra, acidified with HCl, whose conc. of Ra (metal) ranged from 2.1×10^{-9} to 2.3×10^{-8} g. were stored in 2 types of glass vessels, some in ordinary glass, others in Jena, for various periods, and their content of emanation detd. for equil. conditions by the electroscopic method. The elec. capacity and the potentials corresponding to the scale readings were carefully detd. The value of the

ionization current can then be expressed in abs. units. The av. of 10 detns. using a cylinder 6.5 cm. high, 7.1 cm. diam., capacity 4.34, gave 3.19×10^6. e.s.u. for the ionization current produced by 1 cc. of the emanation in equil. with 1 g. Ra. The value of the current produced by 1 cc. when the ionization chamber was 25.2 cm. high, and 7.1 cm. in diam., capacity, 6.33, was found to be 3.84×10^6 e.s.u., av. of 40 detns. The kinds of glass did not affect the results.

251   Soddy, F.   The Interpretation of Radium, 3rd ed. Rev. N. Y., Putnam.   1912(?).

252   Soddy, F.   "Origin of Radium."   Engineering 93, 389-90(1912?).
     General discussion.

253   Soddy, F.   "Origin of Radium."   Rev. gen. sci. 22, 343-7(1912?).
     General discussion.

254   Whytlaw-Gray, R. and Ramsay, W.   Jahrb. Radioakt. u. Elektronik 9, 496-509(1912).
     Dehydrated $RaCl_2$ can be obtained from $RaSO_4$ by dehydrating the sulfate in dry air at 300° then bringing it to red heat in a currrent of HCl and CCl_4 in a quartz tube. No loss of Ra is experienced. The resulting $RaCl_2$ has a density of 4.9. The bromide, $RaBr_2$ can be obtained from the chloride in a similar manner using HBr gas. The density of the bromide is reported to be 5.78.

255   Whytlaw-Gray, R. and Ramsay, W.   "Atomic Weight of Radium."   Proc. Roy. Soc. (London) A 86, 270-90 (1912).
     The final value arrived at is 226.36 for the at. wt. of Ra, thus confirming M. Curie's results but disagreeing with Hönigschmid's. The density of $RaBr_2$ is reported to be 5.78.

256   Whytlaw-Gray, R. and Ramsay, W.   "The Atomic Weight of Radium."   Z. physik. Chem. 80, 257-79 (1912).
     The work of previous investigators is reviewed and discussed. The authors used quartz vessels only in their work, which is given in detail. The sulfate was transformed into the chloride by heating in an atm. of HCl and CCl_4. The detns. were based on the transformation of $RaCl_2$ into $RaBr_2$ and the $RaBr_2$ back to $RaCl_2$. $RaCl_2$ is converted into $RaBr_2$ by heating in a current of HBr gas; the bromide into chloride as above. It is concluded that the at. wt. is 226.36. If only α-particles (He atoms) are given off in the disintegration of U, the difference in at. wt. between U and Ra = 11.98 (3.994×3); the at. wt. of U by Richards = 238.41 and 238.41 − 11.98 = 226.43. If the Ra series ends in Pb after giving off 5 particles, one would expect the at. wt. of Pb to be 226.4 − 19.92 = 206.48 instead of 206.97 reported by Clark or 207.1 as given by Baxter. This might be explained in one of the following ways: (a) Pb is not the final product of the disintegration of Ra however, there is no known element of at. wt. 206.5 and there is no place in the periodic system for such; (b) the at. wts. of U and Ra are approx. 0.5 unit too low. This is not impossible if the value reported (226.4) be considered as only a minimum; (c) during the transformation of Ra into Pb a number of β-particles escape sufficient to explain the

1912

difference of 0.6 unit; (d) if He is not the only gaseous dis-integration product, the calculations based on such an assumption are valueless. It is urged that new detns. of the at. wts. of U and Pb are necessary; the at. wt. of Pb must be close to 207, but on adding 20 a value (227) is obtained for Ra, essentially higher than reported; however, the re-sult reported is considered as a minimum value, since all probable impurities would lower the true value. The sulfates of the alkalies and alkali earths are readily converted quantitatively into the chlorides by heating in an atm. of HCl + CCl_4. On converting $BaCl_2$ into $BaBr_2$ as with Ra, the values 137.37 and 137.32 were found for the at. wt. of Ba.

1913

257   Curie, M. and Onnes, H. K. "Radiation of Radium at the Temperature of Liquid Hydrogen." Radium, Le 10, 181-6(1913). (Communication No. 135 from the Phys. Lab., Leiden.)

The experiments were made on the penetrating γ-rays from Ra in equilibrium with its products (to RaC). The tube containing the Ra was placed in a copper test tube just fitting into a vacuum test-tube into which liquid hydrogen could be poured. The tubes were surrounded by an airtight ionization vessel, the thickness being sufficient to cut off β-rays. The ionization was balanced by an ioni-zation current in a secondary chamber due to γ-rays from a secondary radium preparation. Liquid hydrogen was then poured in and a change in the balance looked for. Only a few experiments could be made, and the authors state that it would have been desirable to have made a greater number and to continue these during a greater length of time. Nevertheless the results show that cooling the radium down to the temperature of liquid hydrogen (20.3° absolute) during a period of 1 1/2 hours does not cause a change in the γ-radiation of 1 in 1000, and probably not even of 1 in 5000.

258   Ebler, E. "Quantitative Estimation of Radium by the Emanation Method." Z. angew. Chem. 26, (Aufsatz.) 658-61(1913).

An app. for estg. Ra by the Em method is described. It consists of a flask to hold the soln., with a capillary lead-in tube provided with a tap. By means of a ground joint, the flask is attached to a small condenser, provided at the upper end with a tap. This tap is connected by a 2nd ground joint to a bulb, provided above and below with taps. After the Em is driven out by boiling the soln. under decreased pressure, a soln. is admitted to the flask through the capillary lead-in tube in order to drive the Em into the bulb. The lower tap of the bulb is then closed, and the latter detached from the flask, after which the Em is admitted to the ionization chamber of an electroscope. Measurements follow the usual methods.

259   Ebler, E. German Pat. 274,874 (1913).

A method of the reduction of crude Ba-Ra sulfate with CaH_2 is described.

260   Ebler, E. German Pat. 278,260 (1913).

In a process of working mixtures containing radium or mesothorium, the crude sulfates are mixed intimately with CaC_2 or materials yielding it, and heated for 6-8 hrs., with

1913

exclusion of air, to a bright red. The product is extd. with H_2O or acid or with solns. of acid salts. By the reducing action of the carbide and of the resulting Ca vapor, the sulfides are formed from the sulfates, and these sulfides dissolve in dil. HCl or HOAc, while the PbS formed at the same time is insol. in these solvents. The SiO_2 present in the crude sulfates is reduced at the high temp. to elementary Si or rendered insol. in dil. acid, thereby losing the property of taking Ra out of soln. by adsorption and fixing it, just as the PbS lost this property. The other products of the heat treatment, such as the Fe, Mg, Sr and Ca compds., as well as the Ca of the carbide, go into soln. in the dil. HCl as chlorides, so that upon evapn. of the lye, only crude chlorides are obtained. From these, pure Ra-Ba chloride or Ra-Meso-Th-Ba chloride may be converted, as by treatment with H_2SO_4, into sulfates and these may be converted, through the carbonates, into pure chlorides.

261   Ebler, E. German Pat. 296,132 (1913).

A method for the extraction of radium from earths poor in Ra is described.

262   Ebler, E. and Bender, W. "Purification and En-riching of Crude Radium Barium Chlorides." Ber. 46, 1571-3(1913).

By treating the crude Ba-Ra chlorides with HCl gas, the Ba and Ra chlorides are pptd. The Ra is more readily pptd. than the Ba. Practically all of the Ra present in the crude material is pptd. in the first fractions, while only 3/4 of the Ba is pptd.

263   Ebler, E. and Bender, W. "The Use of Calcium Hydride for the Autoreduction of 'Crude Sulfates' in the Preparation of Radium and Mesothorium." Z. anorg. Chem. 83, 149-58(1913).

By this method all the sulfates are reduced to sulfides, and by a single operation the Ra and other alk. earths are obtained in a form which is sol. in HCl. The process presents 2 advantages over the older methods; a dis-advantageous equil. does not occur, as is the case with the transformation of the sulfates with alk. carbonates solns., and, secondly, on account of the small solubility of PbS in HCl, most of the Pb can be sepd. from the Ra in the same operation. The process possesses the further advantage that the reduction proceeds automatically and does not require heating. The CaH_2 reacts with the sulfates in accordance with the equation $MeSO_4 + 4CaH_2 = MeS + 4CaO + 4H_2$. The evolved H breaks up the reaction mass so that after-wards it is easily pulverized. When the H ceases to burn, the reaction is ended. The procedure is as follows: The completely dry and finely powdered sulfate, after being mixed with finely powdered CaH_2, is pressed into a crucible anf fired by means of Mg ribbon and a priming mixt., as in the thermite process. The reaction proceeds violently, and the H burns off in a few mins. Since SiO_2 is not reduced under these conditions, only just enough CaH_2 is added to reduce the sulfates present. The violence of the reaction increases with the amt. of Pb present, and mixts. with more than 20% of Pb are dangerous in large quantities. The product is then quickly stirred into hot dil. HCl, free from H_2SO_4, and the H_2S expelled by boiling. If Pb is present N HCl is used, as PbS is insol. in acid of this strength, while when Pb is absent

1913

5 N acid is employed. By passing HCl into the soln. until $3/4$ of the $BaCl_2$ is pptd., all the Ra is carried down. With the crude sulfate from carnotite, where equal parts of sulfate and CaH_2 were used, the pptd. $BaCl_2$ weighed 37% of the sulfate taken, and contained 80.5% of all the Ra. With other crude sulfates, the pptd. $BaCl_2$ contained 86.2% of all the Ra present. The reduction is very complete and the method shortens the process of extracting Ra.

264   Ebler, E. and Bender, W. "Fractional Adsorption and Fractional Disadsorption of Radium-Barium Salts by Colloidal Manganese Perhydroxide." Z. anorg. Chem. 84, 77-91(1913).

The use of colloidal SiO_2 in the conc. of radioactive substances has been described in a previous paper. It has now been found that for the sepn. of Ra from Ba salts better results are obtained with hydrated MnO_2. This is shaken up with the Ra-Ba soln. at ordinary temp. for about 1 hr., and the proportion of Ra to Ba adsorbed is then always greater than that which occurs in the original soln. The extent of the conc. varies with the quantity of ppt. used. With 20 mols. of MnO_2 to 1 mol. of the mixed salts the adsorption of Ra is complete. The presence of a large excess of a neutral salt is favorable. Fractional disadsorption of the metals taken up by the colloidal ppt. may be brought about by treating with dilute acid, by salt solns., or by the action of an elec. current. Any hydrated MnO_2 pptd. from soln. is suited for the selective adsorption of Ra, providing it has not been already satd. with regard to its adsorption for the alk.-earth metals during its prep. The pptn. should, therefore, not be made in solns. containing salts of these metals. Suitable methods for the prep. of the adsorbing reagent consists in reducing alk. permanganates in dil. soln. with $MnCl_2$, or MeOH; or in treating manganous salts with an oxidizing agent as H_2O_2.

265   Fajans, K. Ber. 46, 422(1913).
An article on radium isotopes.

266   Fajans, K. Physik. Z. 14, 131-6(1913).
An article on radium isotopes.

267   Fajans, K. Radium, Le 10, 57-61, 171(1913).
An article on radium isotopes.

268   Fletcher, A. L. "The Determination of Radium in Radioactive Substances." Phil. Mag. (6), 26, 674-7 (1913).

A small splintered and weighed fragment of the radioactive mineral or salt (0.01-0.001 g.) is placed in a hollow in a C rod, and this is heated to 2000-3000° for from 10 to 30 secs. in a closed micro-furnace by the passage of an elec. current of 10 amp./mm.² cross-section. The app. is connected by capillary tubing to an electroscope, and the change of leak is observed as usual. The escape of Em is regarded as practically instantaneous, and since no initial powdering of the mineral is necessary, the loss in the cold is disregarded. The % error by the method is small. Expts. at different temps. with uraninite show that Em does not come off readily below 750°, near which temp. rapid increase in the amt. liberated takes place. Complete de-emanation takes place at full redness. In investigating solns. (as in dealing with filtrates) an accurately known small quantity of the soln. is placed on the C rod by a capillary pipette and the C rod is examd. after a month.

1913

269   Freundlich, H. and von Elissafoff, G. "Valency of Radium." Physik. Z. 14, 1052-7(1913).

The reduction of the electric osmose of water by electrolytes shows a well-marked dependence upon the valency of the ions, being much stronger in multivalent than in univalent ions. This suggests a method of determining the valency of an element which is only available in small quantities. The authors work out a method of observing the flow of the liquid past a bubble in a capillary tube. The amount of the cation need not exceed 0.01 or even 0.001 mg. Experiments with RaBr put it in the same category as Mg or Ba salts, and its bivalence is thus corroborated.

270   Geiger, H. and Nuttall, J. M. "Ranges of the Alpha Particles from the Thorium and Actinium Products." Phil. Mag. (6), 24, 647-54(1913).

Ranges of α-particles (in air?) at 0 and 15° (cm.) and initial velocity ($\times 10^6$) cm./sec.) given for Ra (3.13, 3.30, 1.61), $ThX(Ra^{224})$ (4.08, 4.30, 1.75), and $AcX(Ra^{223})$ (4.17, 4.40, 1.77).

271   Glaser, F. German Pat. 272,429 (1913).
A method for the extraction of $MsTh_1$ (Ra^{228}) from monazite sand is described.

272   Glaser, F. Chem. Z. 37, 1105(1913).
The separation of ThX (Ra^{224}) from RdTh (Th^{228}) is described.

273   Hahn, O. and Rothenbach, M. Physik. Z. 14, 409(1913).
The half-life of AcX (Ra^{223}) is reported to be 11.6 days.

274   Hess, V. F. "Modifications and the Results of Experience in the Measurement of Radium by the Gamma-Ray Method." Physik. Z. 14, 1135-41(1913).

The object of the investigation was the exam. of the Wulf quartz fiber electroscope for γ-rays, with reference to its fitness for standardization, so as to enable one to carry out absolute Ra measurements by the γ-ray method, without the use of a Ra standard. The form of the electroscope was changed to that of a vertical cylinder of 968 cc. capacity the height being approx. equal to the diam. The microscope was fixed directly into one of the vertical walls opposite an airtight window for the observation of the quartz fiber system, which hangs in the vertical axis of the cylinder. This form gave satisfactory satn. currents over the range of 100-300 v. for the max. rate of discharge of 2.4 v. per sec. But in testing with relation to the law of the sq. of the distance of the prep. from the electroscope, the discharge was too great with increasing distance, the discrepancy reaching the value of 10% at the greatest distance. This was due to the proximity of the wall or other objects in the room from which the secondary penetrating radiation is set up by the primary penetrating rays. To obviate this difficulty, it is recommended to have both prep. and electroscope at least 2 m. from the walls, employing, of course, some standard distance between prep. and electroscope, depending on its calibration and the strength of the radiating source being examined. A description is also given of a new method and app. for the rapid direct reading of radioactive values by the γ-ray method. This consists of a large flat cylinder (20 cm. in diam.) entirely closed and placed vertically so as to receive the γ-rays through one of the walls of Zn, 5 mm. in thickness. The

1913

vertical electrode is a metal plate, 15 cm. in diam., insulated by amber, and is connected with an Elster and Geitel single fiber electrometer. A normal battery of the Krueger type furnishes 300 v., and the necessary high resistance in series with the electrometer is the mixt. recommended by Campbell (10 parts xylene to 1 part abs. alc.) contained in a sealed vessel provided with Pt electrodes. With this arrangement, the deflection of the electrometer was strictly proportional to the γ-ray radiation; and in using a standard for comparison, one may, for convenience, choose the distance from the ionization chamber such that one scale division equals one mg. of Ra, or any other suitable quantity.

275   Hess, V. F. "Radium Measurements by the γ-Ray Method." Verhandl. deut. physik. Ges. 15, 1002-16 (Paper read before the 85 Naturforscherversamml., Wien.)

Wulf's double-fibre string electrometer may be used for the the measurement of the strength of Ra or mesothorium preparations by means of the ionization produced within the electrometer case by the γ-rays of the preparation when placed at a certain distance (say, 1 m. for 30 mg. metallic Ra) from the preparation. When the capacity and sensitiveness of the electrometer are accurately known, the Ra measurement may be made an absolute one with the knowledge of the ionizing power of γ-rays and the amount of γ-rays emitted by a given quantity of Ra. The absolute measurement thus made is liable to errors of 2 or 3 per cent. Comparisons with standard preparations may be made to within 1/5 per cent. The sensitivity preferred is 4 volts per division. The wall of the case consists of brass 3 mm. thick. The author also describes a method not involving a time measurement. It employs a single-fibre electrometer, with the ionization chamber grounded through a zylol resistance and connected to the fibre. The deflection of the fibre is accurately proportioned to the ionization.

276   Hönigschmid, O. "Revision of the Atomic Weight of Radium by Analysis of Radium Bromide." Monatsh. 34, 283-309(1913).

The bromide used for the detn. was prepared from $RaCl_2$, with which the value 225.95 had been obtained for the At. wt. of Ra. The bromide was recrystd. repeatedly. From 7 preps., each representing a diff. number of crystns., the same value was obtained for the at. wt. of Ra. Besides the criterion of purity, spectroscopic exam. showed the bromide to be absolutely free from Ba. Six detns. were made to ascertain the ratio $RaBr_2$/AgBr. In all 5.06791 g. of $RaBr_2$ were used, which yielded 4.93389 g. of AgBr, whence the at. wt. of Ra, assuming 107.88 for Ag and 79.916 for Br, has the value 225.96 ± 01. From 2 analyses it was found that 1.28825 g. of $RaBr_2$ require 0.72045 g. of Ag for the formation of the Ag salt, whence the at. wt. of Ra has the value 225.97. Whytlaw-Gray and Ramsay's work is discussed, and it is pointed out that they have made a const. error in the vacuum correction employed in their calculations. Two detns. of the at. wt. of Ra, in which the method of Whytlaw-Gray and Ramsay was employed gave Ra = 225.94.

277   Ikle, M. Chem. News 107, 97(1913).
An article on radium isotopes.

1913

278   Ikle, M. Jahrb. Radioakt. u. Elektronik 10, 188(1913).
An article on radium isotopes.

279   Lorenzen, J. German Pat. 278,121 (1913).
Processes used heretofore for obtaining thorium-X (Ra^{224}) are troublesome and costly and require either large amts. of H_2O for soln. or yield an impure product with considerable amts. of NH_4 salts or NaCl. A sepn. of the ThX from the Th can be effected by subjecting a colloidal ThO_2 soln. containing ThX to dialysis. The ThX passes through, while the colloidal ThO_2 remains in the dialyzer. In this manner a very pure concd. soln. of ThX is obtained. If this soln. is removed and replaced by distd. H_2O, uniform solns. of ThX may be removed, at definite periods, since ThX forms continuously from the Radio-Th contained in the ordinary ThO_2. The colloidal Th soln. can be prepared by pptg. $Th(OH)_4$, with NH_4OH, from a conc. $Th(NO_3)_4$ soln. containing, besides Th, also Radio-Th and ThX, washing the ppt., and digesting with a little H_2O after the addition of a little $Th(NO_3)_4$.

280   McCoy, H. N. and Viol, C. H. Phil. Mag. (6), 25, 334-8(1913).
Methods for the separation of $MsTh_1$ (Ra^{228}) and ThX (Ra^{224}) salts from a solution of thorium salts are described. Adsorption methods used primarily.

281   McCoy, H. N. and Viol, C. H. Phil. Mag. (6), 25, 351(1913).
The half-life of ThX (Ra^{224}) is reported to be 3.64 days.

282   McCoy, H. N. and Leman, E. D. "The Transformation Constant of Actinium X." Physik. Z. 14, 1280-2(1913).
Redetn. of decay constant for AcX (Ra^{223}) by α-ray method yields $t_{1/2}$ = 11.35 days. Purification carried out by Th carrier pptn. for RdAc removal and $BaSO_4$ carrier for Ra pptn.

283   Meyer, Stefan. "A Notice Regarding the New Value for the Atomic Weight of Radium." Physik. Z. 14, 124(1913).
Although the at. wt. of Ra, as recently detd. by Hönigschmid does not agree with the value deduced from the at. wt. of U, the difference between the at. wt. of Pb and Hönigschmid's value for Ra is exactly equal to 5 times the wt. of the α-particle.

284   Meyer, S. Sitzber. math.-naturw. Klasse Akad. Wiss. Wien 122, 2a, 1091(1913).
A method for the determination of the half-life of radium is described.

285   Moore, R. B. U. S. Pat. 1,165,692 (1913).
A method for leaching radium ore with Na_2CO_3 and NaOH is described.

286   Radcliffe, S. Proc. Roy. Soc. N. S. Wales 47, 145(1913).
Experiments on the use of $NaHSO_4$ for the extraction of radium from earths poor in Ra are described.

1913

287   Russel, A. S. Chem. News 107, 49(1913).
   An article on Ra isotopes.

288   Swinne, R. "Some Relationships between Radio-
        active Elements Which Emit Alpha Rays." Physik.
        Z. 14, 142-5(1913).
   For all elements which emit α-rays there exists a quant.
relationship between the decomp. const., λ, and the initial
velocity, v_a, of the α-particle. This relationship is ex-
pressed either by the equation, $\log \lambda = A + B \log v_a$, or by
the equation, $\log \lambda = a + bv^n$; where A and a are consts. for
any radioactive series, and B and b are general consts.
Both equations give the same values for v_a. The consts.
have the following values: B = 156 and b = 42.5, in all 3
radioactive series; A = -43.1 and a = -79.5, in the U series;
A = -44.0 and a = -80.7, in the Th series; and A = -45.2
and a = -82.7, in the Ac series. v_a has been calc. for 20
substances emitting α-rays, and the values obtained agree
closely with the experimental values obtained by Geiger and
Nuttall. The difference between the initial velocity of an
α-particle emitted by a member of one radioactive family
and that emitted by its analog of another radioactive series
is const. For the Ra and the Th series this difference is
0.13×10^9 cm./sec., and for the Ra and the Ac series it is
-0.20×10^9 cm./sec. Further, for those substances which
emit α-particles, the ratio of the decomp. consts. of
analogous members of diff. radioactive series is approx.
const. The foregoing results suggest a new arrangement of
the last members of the radioactive deposits.

289   von Hevesy, G. "The Electromotive Series of the
        Radio-Elements." Radium, Le 10, 65-9(1913).
   Radio-elements are arranged in a series. Methods used in
determining the positions are discussed. Ra and its isotopes
are the most electropositive of the radio-elements according
to the arrangement shown.

290   von Hevesy, G. "The Electromotive Series of the
        Radio-Elements." Z. Elektrochem. 19, 291-5(1913).
   This article presents the same data as the previous paper.

291   von Hevesy, G. "The Valency of the Radio-Elements."
        Phil. Mag. (6), 25, 390-414(1913).
   Discussion includes data on diffusion constants and
mobilities of Ra, ThX (Ra^{224}) and AcX (Ra^{223}). These are
reported as, 0.667, 57.3; 0.659, 58.0; and 0.664, 56.1
respectively. Each of the isotopes is reported to have a
valence of 2. Results for other radio-elements are also
included.

292   von Hevesy, G. "The Valency of the Radio-
        Elements." Physik. Z. 14, 49-62(1913).
   Article reports the same information as the previous
reference.

293   von Hevesy, G. Physik. Z. 14, 1202-5(1913).
   The diffusion coefficient of MsTh$_1$ (Ra^{228}) ions in water
at 18° is 0.66 cm^2/day, the same as the values for the other
radium isotopes. Valence and affinity characteristics are
also discussed.

1914

294   Beer, P. Radium, Le 11, 124(1914).
   An article on Ra isotopes.

295   Bredt, O. P. C. Concentrating the Radium Contents
        of Radium Barium Sulfate Residues. U. S. Pat.
        1,154,230(1914).
   The residues are fused with sufficient alkali, e.g., Na$_2$CO$_3$,
to covert about 95% of the sulfates into acid-sol. form and
the residues are then treated with H$_2$O and HCl to remove
the acid sol. Ba compds. from the RaSO$_4$ which remains as
an insol. residue. The process is repeated until the desired
degree of concn. is effected.

296   Bredt, O. P. C. Concentrating Ores and Residues
        Containing Radium Sulfate. U. S. Pat. 1,154,231
        (1914).
   The material is treated with boiling H$_2$SO$_4$ in small amt.
to dissolve the Ba as bisulfate without dissolving the RaSO$_4$,
the soln. is sepd. and treated with H$_2$O to ppt. mixed sulfates
and the residue is repeatedly treated with small amts. of
boiling H$_2$SO$_4$ to effect fractional sepn. of the Ba and Ra
compds. The latter are dissolved in the last stage of the
process and are pptd. by adding H$_2$O.

297   Burfind, J. H. Chem. Ztg. Repert. 38, 584(1914).
   An article on the extraction of radium from American
carnotite poor in Ra with SO$_2$ in solution.

298   Burfind, J. H. U. S. Pat. 1,095,377(1914).
   A method for the extraction of radium from American
carnotite poor in Ra with SO$_2$ in solution.

299   Cable, R. and Schlundt, H. Chem. Zentr. II, 341
        (1914).
   Article on the extraction of radium from poor American
pitchblende with chlorine.

300   Coehn, A. Ber. 37, 811(1914).
   A method for obtaining a radium amalgam by the electrol-
ysis of a methyl alcohol solution of Ra-Ba salts. The cath-
ode is amalgamated zinc, the anode: silver.

301   Ebler, E. and Bender, W. Sitzber. Heidelberg.
        Akad. Wiss. math. - naturw. Klasse 12, (1914).
   A comparison of the different processes for the extrac-
tion of Ra with a reducing agent is given. Better results
are obtained with strong agents.

302   Ebler, E. and Bender, W. Z. anorg. Chem. 84, 77
        (1914).
   The separation of Ra-Ba chlorides by adsorption with
MnO$_2$ is described.

303   Ebler, E. and Bender, W. "Extraction of Radium
        from Crude Sulfates by Calcium Carbide and Mix-
        tures of Calcium Carbide and Hydride." Z. anorg.
        Chem. 88, 255-64(1914).
   Autogenous reduction of sulfates by CaH$_2$ is profitable
only with rich concentrates. For crude sulfates containing
silicates reduction by C is possible but unless the amt. of
silica is small not more than 30% of the Ra present is con-
verted to sulfide. Using 4CaC$_2$ + MSO$_4$ intimately mixed and

1914

kept at red heat for 4 hrs., about 80% of the Ra is reduced even in the presence of much silicate. Addition of CaH_2 makes the reaction rapid and autogenous but is practicable only when little silicate is present. The process is best used on a large scale because of greater heat utilization.

304   Ebler, E. Radium and Mesothorium Salts.   British Pat. 1,173, Jan. 15, 1914.

Crude sulfates containing Ra or MsTh sulfates are reduced to sulfides by heating with CaC_2. The reaction may be effected without heating if a part of the carbide is replaced by CaH_2, Ca, Mg, Al, or other substance that will react with sulfates in the manner of an aluminothermic mixt.; or CaH_2 or Ca together with an equiv. quantity of a sulfate, may be added to the mixt. of CaC_2 and crude sulfates. The reduced mass is dissolved in H_2O, HCl, or HOAc, and the Ra or MsTh and Ba are pptd. by satg. the soln. with HCl or HNO_3. Practically all the Ra or MsTh salt is deposited before the whole of the Ba salt.

305   Gesellschaft für Elektro-Osmose. British Pat. 10,083 (1914).

In obtaining radium salts, the ions adsorbed in colloids are are exchanged for other ions by treatment with a soln. of an electrolyte, the exchange being made selective by choosing suitable salt solns. at suitable concns. so that closely related elements, such as the rare earths, may be sepd. In an example, a MnO_2 adsorption product of Ra and Ba in a fine state of division is boiled with an Nh_4Cl soln. of stated strength. The solid matter after filtration is stated to contain 32.7% of the Ba and 64.7% of the Ra originally present.

306   Hahn, O. "Distinction between the Penetrating γ-Radiation of Mesothorium and Radium." Radium, Le 11, 71-4(1914).

It is well known that mesothorium is chemically non-separable from radium, so that commercial mesothorium obtained from monazite sands generally contains of the order of 20% of Ra. Estimations of the relative amounts of Ra and MsTh in a specimen are easy by the emanation method, but this involves breaking the containing tube. The author has made careful measurements of the absorption by lead of the γ-rays of various preparations with a view to distinguishing them by this method. The preparations used were: (1) $RaBr_2$, pure. (2) Commercial mesothorium freshly prepared. (3) Commercial mesothorium, 2 years old (i.e., having grown radio-thorium). (4) Freshly prepared mesothorium, free from Ra. (5) Radio-thorium. The electroscope used was of lead with walls 3.3 mm. thick, and the following relative ionizations were obtained:

mm. Lead	(1) Radium	(2) Mesothorium (New)	(3) Mesothorium (Old)	(4) Mesothorium (without Ra)	(5) Radio-thorium.
3.3	100	100	100	100	100
5	84.5	86.7	85.5	87.3	86.5
10	57.6	60.7	60.1	60.8	63.1
15	41.9	44	44.6	43.2	47.1
20	31.5	32.1	33.2	31.5	36.8
25	24.2	23.7	25.2	22.8	29.1
30	18.6	17.7	19.4	16.7	23.3
35	14.3	13.4	15.5	12.2	18.8
40	11.3	9.9	11.8	9.2	13.3
45	9.0	7.5	9.1	6.8	12.4

1914

307   Ikle, M. Radium, Le 11, 124(1914).

An article on radium isotopes.

308   Keetman, B. and Jost, F. U. S. Pat. 1,100,743 (1914).

Recovering salts of mesothorium and radium in extraction of thorium from minerals such as monazite sand by treating the ore with a Ba salt and hot conc. H_2SO_4 and adding sufficient H_2O to form a slimy or muddy product and then adding to this product an aq. soln. containing sufficient $BaCl_2$ or $BaSO_4$ to render the radioactive substances such as MsTh and Ra absolutely insol. so that they may be recovered from the ptt.

309   McCoy, H. N. and Leman, E. D. Phys. Rev. (2), 14, 409(1914).

A method for the separation of $AcX(Ra^{223})$ from actinium preparations is described. The Ac and RdAc are precipitated with ammonia. A little barium salt is added to the filtrate and the AcX is removed from the soln by co-precipitation with $BaSO_4$; or the filtrate can be evaporated to dryness, and the residue heated to expel the other decay products, since since AcX is not volatile at red heat.

310   McCoy, H. N. U. S. Pat. 1,098,282 (1914).

Pulverized radium ore is mixed with diluted or concentrated H_2SO_4; the slurry is heated to 300° or higher. Water is then added to the mixture, the Fe, U, and V salts are dissolved, and insoluble $RaSO_4$ remains.

311   McCoy, H. N. U. S. Pat. 1,103,600, July 14.

Concentrating and separating Ra, $Msth_1(Ra^{228})$ and ThX (Ra^{224}) from Ba compds., by partially pptg. the hydroxides of Ba and the radioactive metals by NaOH or KOH and fractionally sepg. the $Ba(OH)_2$ from soln. by crystn. and addition of more NaOH or KOH. The Ba compds. remaining in soln. after the first pptn. are richer in radioactive compds. than the ppt.

312   Radcliffe, S. Chem. Zentr. I, 1990(1914).

Experiments on the fusing of carnotite with $NaHSO_4$ are described.

313   Radcliffe, S. J. Soc. Chem. Ind. (London) 33, 229 (1914).

Experiments on the fusing of carnotite with $NaHSO_4$ are described.

314   Ramsauer, C. Radium, Le 11, 107(1914).

The detection of $ThX(Ra^{224})$ and $AcX(Ra^{223})$ by the emanation method is described.

315   Russell, A. S. and Chadwick, J. "γ-Rays of Polonium, Radium, and Radio-actinium." Phil. Mag. (6), 27, 112-25(1914).

Radium itself freed from its products is found to emit three types of γ-rays with values of μ/D in Al of 130, 6, and 0.1 cm^{-1}. The intensity of the γ-radiation of Ra itself is from 1 to 1½ per cent of that of Ra in equilibrium with its short lived products. The results show further that

1914

Radio-Ac emits two types of γ-rays, the values of μ/D in Al being 8 and 0.1

316   Schlundt, H. "Quantitative Determination of Radium." Trans. Am. Electrochem. Soc. 26, 163-79 (1914).

The paper commences with a discussion on the relative merits of the various methods of separation and collection of RaEm from the ore, the Ra content of which is required. Two standard methods of separating the emanation from the specimen are outlined: (1) The "solution" method, and (2) the "fusion" method, introduced by Joly. The author states that the results obtained by the fusion method are generally higher than the values by the solution method. In the latter case it is difficult to avoid forming slight precipitates in the solutions, and these probably cause the separation of some Ra which does not release its emanation completely on boiling. Since the apparatus designed by Joly is rather expensive, experiments have been directed towards devising and testing the accuracy of a simple fusion method which can be conducted with inexpensive apparatus. For a description of this apparatus and the various methods used for separating and collecting the emanation the original paper must be consulted. Tables containing the results from analyses of the following minerals are given: Uraninite, carnotite concentrate, carnotite ore, spring deposit. In all, 12 different methods of separating the emanation have been employed and the mean value of a number of determinations by each method is given. From a consideration of the tables the author draws the following conclusions: (1) The solution method, that is, fusion with mixed carbonates, followed by solution and boiling, gave results that are only 70 to 80% of the values obtained by the fusion method with mixed carbonates. (2) Fusion with mixed carbonates appears to be superior to fusion with potassium acid sulfate, (3) Fusion with borax probably gives a low result as a result of the retention of some of the emanation in the 'melt'. At the temperatures attained in the experiments the evolution of gas, and its flow through the melt, is necessary for complete release of the emanation. (4) High emanating power in the cold indicates a large release of emanation by heating. In the case of a specimen of carnotite ore a rough assay may be made by merely heating to bright redness. (5) A complete separation of the emanation from uraninite is obtained by solution in nitric acid and by fusion with some of the ordinary fluxes. No experiments were conducted with the resulting fused mass to ascertain whether the equilibrium quantities of emanation can be again separated by a subsequent fusion. In the discussion, S. C. Lind gave a short account of his determinations of the Ra/Ur ratio in carnotites, obtaining results by the solution method 10 to 20% low, in agreement with the results mentioned above. He also found that the fusion method, successful with carnotites, is a complete failure under the same conditions for crude sulphates, while the solution method succeeded with pitchblende but failed with carnotites. These observations render the variety of methods described in the present paper all the more valuable. W. G. Brown communicated a brief resume of some experiments on this problem which he had carried out in collaboration with O. E. Sheppard. Their determinations by solution in sulfuric and nitric acids are in fair agreement with the results obtained in the present experiments, but the lower values by fusion with mixed carbonates stand in direct contrast to the higher values of the author.

1914

317   Stern, H. German Pat. 280,694 (1914).

A method for the separation of Ra-Ba salts with permutite and zeolite is described.

1915

318   Bothe, W. "Determination of the Radium Content of Weakly Radioactive Substances by Gamma-Ray Measurements." Physik. Z. 16, 33-6(1915).

Solid substances having a Ra content as low as 4×10^{-6} mg. Ra/cc. may be measured by the γ-ray method more conveniently than by the usual Em method by using a special form of electroscope. B. describes a cylindrical form of electroscope 32 cm. high, 20 cm. in diam., and lined internally with Pb 0.5 mm. thick. The central electrode, which stands vertically from the bottom where it is insulated by a ball of S, consists of a hollow cylinder of brass 16 cm. high and 2.8 cm. internal diam. lined on the outside with Pb. The cylindrical electrode is round at both ends and is provided above with a removable cap through which the solid material to be examined is introduced after being sealed in a glass test-tube which just fits inside the cylinder. The distance between the bottom of the electrode and the insulation is 11 cm., which permits the Au leaf to be attached just below the bottom of the cylinder. The leaf is observed in the usual way by means of mica windows in the wall of the outer cylinder. The central electrode carrying the leaf system is charged from above. Several advantages are attained by placing the active material inside the inner electrode. The radiation is effective in all directions, and the effective vol. is const. and definite. Two kinds of corrections must be taken into account, the absorption of the radioactive material itself, and its special distribution inside the electrode with respect to its radiation. The latter was examined by placing a point source of radiation at various points inside the cylinder, with the result that the mean was found to be represented by the center of the cylinder. The absorption correction was examined by using a point source buried at various locations in the cylinder filled with silica as absorbent. Again the conclusion was reached that the av. of the entire vol. is represented by the center, and therefore it is only necessary with different absorbent materials to make one measurement with a point source at the center. This correction for SiO_2 was 7.5%; for $PbCrO_4$, 26.3; for a mixt. of SiO_2 and $PbCrO_4$, 17.2; for CaO, 3.7; and for a pptd. weakly active $Ba(Ra)SO_4$ (sp. gr. 0.53), 4.9. For substances of d. <1 the percentage is given by multiplying the d. by 7. The result for SiO_2 by the point method was verified by taking 2 equal quantities of Ra salt, one of which was used to impregnate the SiO_2, and the other was sealed as a point source. The correction in this case was found to be 8.2%. The percentage accuracy of the measurements decreases with the Ra content until the error reaches 7% for material containing about 4.2×10^{-6} mg. Ra/cc. This would easily include high grade pitchblende and most crude sulfates but not the usual grades of carnotite nor any of the other low grade minerals nor radioactive rocks for which the Em method must be used.

319   Danforth, C. W., Samuels, W., and Martersteck, W. U. S. Pat. 1,126,182 (1915).

A method for obtaining $BaCO_3$ and $RaCO_3$ by leaching carnotite with H_2SO_4 and treating the residue with NaOH and Na_2CO_3.

1915

320   Ebler, E. and Bender, W. Z. angew. Chem. 28, I,
        33-41(1915).

Discussion included on fractional pptn. of $RaCl_2$ from
alcohol; adsn. sepn. of Ra-Ba salts using silicic acid; frac-
tional crystallization of Ra salts from pricrate, bromide,
ferrocyanide, and silicofluoride solns.; fractional pttn. from
HCl for $RaCl_2$; redn. of crude Ra-Ba sulfate with CaC_2 and/
or CaH_2; several methods using $NaHSO_4$, NaCl, NaOH, and
alkali-lye mixtures for leaching of carnotite, sulfate, and
low-grade Ra ores.

321   Keetman, B. "Obtaining Radiothorium and Solutions
        Containing Thorium-X." U. S. Pat. 1,151,187 (1915).

The material under treatment is pptd. with NH_4OH and
the mixt. of ppt. and supernatant liquid thus obtained is
evapd. to dryness and washed with H_2O to remove the NH_4
salts and leave a dense pure radiothorium hydroxide from
which a soln. containing Th-X(Ra^{224}) is made by treatment
with H_2O or dil. NaCl soln. and shaking.

322   Lind, S. C. "Practical Methods for the Determina-
        tion of Radium. I. Interchangeable Electroscope
        and Its Use." J. Ind. Eng. Chem. 7, 406-10(1915).

L. describes a new electroscope of very simple construc-
tion made in 2 detachable parts; the upper the telescope and
leaf system, and the lower the discharge chamber. The for-
mer can be used on any number of sep. lower parts. The
method of procedure in making detns. by the emanation
method is described.

323   Lind, S. C. "Practical Methods for Determina-
        tion of Radium. II. The Emanation Method." J. Ind.
        Eng. Chem. 7, 1024-9(1915).

Methods are given for the chem. treatment and other
·manipulations involved in preparing Em for electroscopic
measurements. A soln. containing an excess of Ba in a rath-
er high concn. of HNO_3 is recommended as the best medium
for storing Ra in soln. without danger of loss through pptn.
Ra solns. for use in analysis and which are low in Ba and
HNO_3 should, therefore, have these reagents added before
allowing to stand to collect Em. In cases where no Ba but
an excess of a Ba precipitant, as sulfate, is present, it is
suggested to add a suitable vol. of the Ra sample to a soln.
containing Ba in excess; the ppt. is filtered off, and the
filtrate acidified with HNO_3, boiled and sealed; the ppt. of
$BaSO_4$ is fused with Na_2CO_3-K_2CO_3 mixture, sealed in a
glass tube for a known time, and the accumulated Em
then drawn into the electroscope by suction before and
after treatment of the fusion with HNO_3 heated to boiling.
For convenience the filtrate may be sealed at the same
time as the fused ppt. in order that both lots of Em may
be introduced into the same electroscope. Instead of
boiling the fused mass in acid as in the analysis of Ra-
bearing $BaSO_4$, or other insoluble material, fusion may be
employed both before and after the collection of the Em if
preferred.

324   McCoy, H. W. Chem. Ztg. Repert. 39, 136(1915).

The fractional crystallization of radium hydroxide is de-
scribed.

325   McCoy, H. N. and Leman, E. D. "The Relation
        between the Alpha-Ray Activities and Ranges of Ra-

1915

dium and Its Short-lived Products." Phys. Rev.
(2), 6, 184-91(1915).

It has been shown that for the Th and Ac series of the α-rays
activity for each substance present, as measured by the ion-
ization current, is proportional to the 2/3 power of its range.
Further proof of the rule is that the ratio of the activities
of RaEM + RaA + RaC to that of Ra itself as calcd. on this
basis is 4.09 and the ratio measured as 4.11. The Ra was
prepared free from decomp. products by bubbling air through
10 cc. of a dil. soln., heated almost to boiling, for 30 min.
to remove RaEm and to allow RaA to disintegrate completely.
$Pb(C_2H_3O_2)_2$ was added and pptd. with RaB, RaC, RaD, RaE,
and RaF by H_2S. The treatment was twice repeated. The addi-
tion of $BaCl_2$ and H_2SO_4 then pptd. the Ra, which was spread
over a brass plate in alc. suspension and dried. The final
measurements, made after the disintegration products had
accumulated for 6 months, were corrected for β-ray activity,
escaped Em, and loss by recoil.

326   Moran, J. "A Comparison of Radium Standard
        Solutions." Phil. Mag. (6), 30, 660-4(1915).

The week Rutherford-Boltwood standard soln. at McGill
Univ., with 1.57×10^{-9} g. Ra/cc. was found 2% lower than
the Washington standard; the strong standard soln., 100
times as strong, is 4% lower than the Washington standard.
The measurements were made by the Em method, the Em
being driven from the soln. by boiling and measured in a
gold-leaf electroscope. On successive boilings the solns.
lose their emanating power and give results 10% too low,
but the full value is restored by the addition of HCl soln.
(19%). No explanation of this is offered.

327   Parsons, C. L., Moore, R. B., Lind, S. C., and
        Schaefer, O. C. Extraction and Recovery of Radium,
        Uranium, and Vanadium from Carnotite. Bureau of
        Mines, 1915. (Bulletin No. 104) 124p.

This publication gives a detailed description of the commer-
cial separation of radium from carnotite. The work has been
carried out as a result of a cooperative agreement of the
National Radium Institute and the Bureau of Mines. After a
lengthy introduction, in which the details of the plant, etc.,
are considered, the different methods of treating radium
ores are given in great detail. Special emphasis is laid on
the Bureau of Mines method for treating carnotite. This is
followed by a description of the methods of refining radium.
Methods of measuring quantities of radium, recoveries and
losses in the various manufacturing processes, and cost data
are fully discussed.

328   Plum, H. M. "Extraction and Separation of the
        Radio-active Constituents of Carnotite." J. Am.
        Chem. Soc. 37, 1797-816(1915).

In view of the increasing demand for radium, any research·
which will point out efficient and practical methods for the
recovery of this element will be of both scientific and practi-
cal value. This paper presents the results of a critical in-
vestigation of various methods of treating carnotite with the
object in view of extracting not only U, V, and Ra, but also
its other long-lived radio-active constituents, ionium, RaD,
RaF, and actinium. Several of the commercial methods now
in use for removing vanadium and uranium from a carnotite
ore have been examined and modified so as to be effective in
treating ore which was found to contain quantities of vanadi-

1915

ferous silicate. In the method finally adopted the U is removed by boiling the carnotite concentrates with a sodium carbonate solution, precipitated as uranyl sodium carbonate by merely concentrating the filtrate, and the soda is again recovered. The radium, actinium, and the radio-lead are contained in the filtrate obtained by boiling the residue (insoluble in soda solution) with hydrochloric acid. That part of the radium still held in the residue is then removed with boiling nitric acid. The ionium is finally recovered from the residue by boiling with sulfuric acid, and is then concentrated with cerium rather than with thorium (from which it cannot be separated).

329   "Radium and Plant Growth." Gardeners' Chronicle
       (3), 58, No. 1501, 209(1915).
    In comments on the results of a number of experiments said to have been carried out by M. F. H. Sutton, it is stated that in no case was it apparent that any of the radium preparations had a beneficial effect on the growth of the crops. In not a few instances there were definite indications that the preparations had exercised an adverse influence on the plants.

330   Vogt, L. F. (to Standard Chemical Company)
       U. S. Pat. 1,129,029 (1915).
    The leaching of carnotite with soda and H_2SO_4 is described. Primary purpose is Ra recovery.

331   von Bayer, O., Hahn, O., and Meitner, L. Physik.
       Z. 16, 6(1915).
    The separation of ThX(Ra^{224}) by electrolysis is described.

1916

332   Barker, H. and Schlundt, H. Met. Chem. Eng. 14, 18
       (1916)
    The reduction of $RaSO_4$ with carbon is described.

333   Buseck, O. "Radium and Its Physical Properties."
       Hahnemannian Monthly 51, 335-50(1916).
    Review. Physiological action is discussed.

334   Danforth, C. W., Samuels, W., and Martersteck, W.
       Chem. Ztg. Repert. 40, 164(1916).
    An article on the leaching of carnotite with H_2SO_4, and treating the residue with NaOH and Na_2CO_3. The silicate is dissolved, $BaCO_3$ and $RaCO_3$ remain.

335   Gleditsch, E. "Life of Radium." Am. J. Sci. 41,
       112-24(1916).
    The author has made a series of measurements on the growth of radium in solutions of ionium preparations separated from different uranium minerals-namely: (1) from uranite (North Carolina), (2) from clevite (Norway), and (3) from broggerite (Norway). The results obtained from the first two minerals indicate that the constant of change of Ra has a higher value than the one generally accepted, 3.48×10^{-4} (year)$^{-1}$. Neither of them, however, can claim a very high degree of accuracy. The objections raised in the case of uranite and clevite do not apply in the case of broggerite, a mineral which is one of the oldest uranites, and particularly free from all alteration products. The results obtained for the most carefully prepared solutions are:- (a) The disintegration constant of radium has a value

1916

of 4.22×10^{-4}(year)$^{-1}$, and 4.14×10^{-4}(year)$^{-1}$. (b) The half-life of Ra indicated is accordingly 1642 years and 1674 years. The result agrees very closely with the value found by Rutherford.

336   Loomis, A. C. and Schlundt, H. J. Ind. Eng. Chem.
       8, 990(1916).
    A description of various experiments for the extraction of radium from American carnotite poor in Ra.

337   McCoy, H. N. U. S. Pat. 1,195,698 (1916).
    A method for the extraction of Ra from carnotite by treatment with acids is described.

338   Moore, R. B. U. S. Pat. 1,165,693 (1916).
    A method for obtaining radium salts by treating the ore with HCl and neutralizing the solution with Na_2CO_3 or NaOH is given, also gives a method for HNO_3 treatment.

339   Moran, J. "A Comparison of Radium Standard
       Solutions." Trans. Roy. Soc. Canada 10, III, 77-84
       (1916).
    The object of this expt. was to re-det. the values of the Rutherford-Boltwood weak and strong soln. standards. They were prepd. in the first place by means of the Rutherford-Boltwood solid standard, now at Manchester Univ., Eng., and this solid standard was found by Rutherford to be 4% low. If no error was made in their prepn. we should expect the soln. standards to come out similarly. Results of last session showed the weak and strong solns. to be 98% and 96% in value, resp., as compared with the Washington standard. Present results show the corresponding values to be 96.4% and 97.3%. In the work of last year it appeared that the $RaBr_2$ solns. deteriorated with each boiling. Also, that if a sufficient amt. of HCl were added, the soln. seemed to recover its emanating power. At that time no pure HCl free from radioactive material was available. The work of the present year with pure HCl proves that the whole of the increase must have been due to the radioactive matter in the HCl. The excess then found was evidently due to lack of refinements in the app. The boiling effect which seemed to be apparent last year was also traced to the same cause.

340   Parsons, C. L. J. Ind. Eng. Chem. 8, 469(1916).
    Experiments on the leaching of radium ores with HNO_3 are described.

341   Parsons, C. L., Moore, R. B., Lind, S. C., and
       Schaefer, O. C. Chem. Ztg. Repert. 40, 84(1916).
    The reduction of crude Ba-Ra sulfate with carbon is described.

342   Schlundt, H. "Extraction of Radium from Carnotite
       Ores." Chem. News 114, 50-3(1916).
    At the present time the carnotite ores of S. W. Colorado and E. Utah constitute the principal source of radium in the U.S.A. The carnotites consists of a sandstone with a clay binder variably impregnated with the mineral carnotite, a hydrous potassium uranium vanadate containing Ba and Ca. By boiling carnotite ores with concentrated H_2SO_4 the Ba and Ra compounds present are converted into bisulfates which remain in solution in an excess of the acid, and may then be separated from the insoluble components by filtration fol-

1916

lowed by washing the residue with concentrated H_2SO_4. From the acid liquors thus obtained the Ra is recovered by diluting with water, whereby barium-radium sulfate is precipitated. The experiments outlined in this paper are based on the preceding principle.

343   Schlundt, H. "Extraction of Radium from Carno-
          tite Ores." J. Phys. Chem. 20, 485-94(1916).
    Article contains information similar to that indicated for the previous reference.

344   Schlundt, H. U. S. Pat. 1,181,411 (1916).
    A method for the leaching of carnotite with H_2SO_4 and separating the Ra-Ba sulfate with water is described.

345   Schlundt, H. U. S. Pat. 1,194,669 (1916).
    A method for the leaching of carnotite with H_2SO_4 and separating the Ra-Ba salts with water is described.

346   Siegbahn, M. and Friman, E. "High-frequency
          Spectra (L-series) of the Elements Polonium, Ra-
          dium, Thorium, and Uranium." Physik. Z. 17, 61-
          2(1916).
    In an earlier paper the results were given of an investigation of the L-series of the elements from Ta to Bi. At least 11 groups of lines were determined. The measurements are now extended to the elements Po, Ra, Th, and U. In the case of polonium (deposited electrolytically on copper), two characteristic lines (α_1, β_1) were observed, and in addition a number of other lines probably due to impurities. Using 0.1 mg. of $RaBr_2$, to obtain the Ra spectrum, only a very weak α-line could be obtained. Both Th and U gave multiple-line spectra. The values of the wave-lengths, relative intensities, etc., of the the various lines are tabulated. Plotting the values of $1/\lambda$ against atomic numbers it is found that the new $\alpha_2\alpha_1$ and β_2-values fall exactly on the same straight line as the old values, while the remainder $(\beta_1, \beta_3, \lambda_1, \lambda_2, \lambda_3)$ are too high.

347   Viol. C. H. J. Ind. Eng. Chem. 8, 284, 660 (1916).
    Experiments on the leaching of radium ores with HNO_3 are described.

348   Vogt, L. F. Chem. Ztg. Repert. 40, 164(1916).
    Experiments on the leaching of carnotite with soda and H_2SO_4 are described.

1917

349   Anslow, G. A. and Howell, J. T. "Triplet Series of
          Radium." Proc. Nat. Acad. Sci. 3, 409-12(1917).
    The spectra of the elements of the second group of the periodic table are characterized by the presence of both doublet and triplet series of the principal, first, and second subordinate types. On plotting the logarithms of the atomic numbers against the logarithms of the frequency-differences between the extreme members of the triplets, it was found that alternate elements fall on straight lines. Hence, the triplets of radium should fall on the line on which Ca, Sr, and Ba lie. From this it follows that the frequency-difference of radium triplets should be approximately 3060. An examination of the known radium lines, as measured by Runge and Precht, showed a number of triplets with the average frequency-difference $v_1 = 2016.64$, $v_2 = 1036.15$ giving $v_1 + v_2 = 3052.79$. Two triplets showed well-marked satellites and

1917

seemed to belong to the first subordinate series. Although a study of the magnetic resolution of these lines will be necessary to establish the triplets, there seems little reason to doubt that the frequency-difference 3053 is characteristic of the radium spectrum. Plotting the logarithms of the frequency-differences against the logarithms of the atomic weights gives similarly a pair of straight lines. Extrapolation gives in one case 87 for the atomic number, and in the other case 231.6 for the atomic weight—values quite close to the true values, 88 and 226. A table is given of the triplets identified up to the present, with tentative Rydberg formulae for the three series.

350   Choudhari, T. C. "Inquiries into Radium Disinte-
          gration." Chem. News 116, 25-7 (1917).
    This communication is mainly concerned with the disintegration of radium halide in aqueous solution, and also to some extent with disintegration in the solid condition of the salt. The author's conclusions are summarized as follows: During the disintegration of a radium halide in aqueous solution the excess hydrogen cannot be satisfactorily explained by any one cause, and may perhaps be due to the consumption of oxygen, partly by ozonization and partly by peroxide formation. When radium halide disintegrates, the gradual diminution in weight cannot be attributed to the gradual disruption of its radium-content alone, but is due to the quantity of metallic Ra disintegrated, plus its equivalent quantity of halogen set free. The fate of the halogen-content in radium halide when metallic Ra has completely disintegrated, giving rise to emanation, remains unexplained.

351   Kohlrausch, K. W. F. "Absorption of γ-Rays of
          Radium." Sitzber. math.-naturw. Klasse Akad.
          Wiss. Wien 126, 441-72 (1917).
    A detailed study has been made of the absorption in Pb and Al of γ-rays from Ra and its decay products. The absorption of a parallel beam of rays has been examined after passing through "filters" of various materials and various thicknesses of the same material. The paper contains a large amount of tabulated information on this question, for particulars of which the original paper should be consulted. It has been shown in the case of a parallel beam of γ-rays from Ra in equilibrium with its successive products, that the form of the absorption curve depends on the method of measurement. A. The absorption does not conform to a simple exponential law, if the secondary radiation originating in the absorber does not reach the ionization vessel. B. The absorption, apart from initial softening, is exponential if the hard secondary rays are measured as a part of the incident radiation.

1918

352   Barker, H. H. "The Bisulfate Method of Deter-
          mining Radium." J. Ind. Eng. Chem. 10, 525-7
          (1918).
    The bisulfate fusion for Rn liberation from various substances in order to detn. the Ra content is described. Apparatus, method, and results are discussed in detail. Comparison of this method with others in use shows good agreement.

1918

353   Cable, R. and Schlundt, H. "Extraction of Radium
        from American Pitchblende Ores by Chlorination."
        Chem. News 117, 244-6(1918).

The experimental results presented in this paper were
obtained by a new method of extracting radium by direct
chlorination of the ore. This method has particular applica-
tion to pitchblende ores in which the uranite occurs intimately
associated with iron pyrites. Good results have been ob-
tained. A few chlorination experiments with carnotite ore
did not give results of promise for a method of extracting
radium.

354   Cable, R. and Schlundt, H. "Extraction of Radium
        from American Pitchblende Ores by Chlorination."
        Met. Chem. Eng. 18, 460-2(1918).

This paper contains information similar to that presented
in the previous reference.

355   Henrich, F. Chemie und chemische Technologie
        radioaktiver Stoffe. Berlin, Springer, 1918.

Page 313 describes various methods for the extraction of
radium from ores poor in Ra. The sepn. of $RaCl_2$ by fraction-
al crystallization is described on pages 205 and 302. The
reduction of Ba-Ra sulfates (crude) using CaC_2 and CaH_2 is
treated on page 315, and on page 342 information on the sepn.
of $ThX(Ra^{224})$ from $RdTh(Th^{228})$ is located.

356   Hess, F. and Lawson, R. W. "Number of α-particles
        Emitted by Radium." Arch. sci. phys. nat. (4), 46,
        330-1(1918). (Paper read before the Soc. suisse de
        Physique, Sept., 1918.)

The only direct experimental determination of this con-
stant is that of Rutherford and Geiger (1908) which gave a
value 3.4×10^{10} or 3.5×10^{10} when corrected to the inter-
national radium standard. On theoretical grounds the authors
considered that a re-determination of this constant was ad-
visable. The method employed was the same in principle as
the ionization by collision method of Rutherford and Geiger.
"Counts" were made in air, CO_2, and in mixtures of air
and CO_2-using the string electrometer of Elster and Geitel.
They found that in air the β- and γ-rays were as effective
as the γ-particles; in CO_2 and in mixtures of CO_2 and air
(containing not less than 54% CO_2) only the α-particles
produced ionization by collision. Thus, in the exact deter-
mination of the number of α-particles emitted from RaC,
in the presence of β- and γ-rays, a mixture of 54% CO_2 and
46% air was employed. The conditions of the experiment
were varied as much as possible and control experiments
carried out frequently. 268 determinations, each count lasting
not less than 10 minutes, gave a value $Z = (3.72 \pm 0.02 \times 10^{10}$
for the number of α-particles emitted/sec./g. of Ra.

The value of Z determined from measurements of the
heating effects and ranges of α-particles of radium gives

$$Z = 3.88 \times 10^{10} \text{ (for a range } r_{15}^0 = 3.30 \text{ cm.)}$$

and

$$Z = 3.78 \times 10^{10} \text{ (for a range } r_{15}^0 = 3.44 \text{ cm.)}$$

Reciprocally, the value $Z = 3.72 \times 10^{10}$, given above, furnishes
a determination of the velocity and of the range of the α-
particles of radium. These values are $v = 1.59 \times 10^9$ cm./sec.
and $r_{-15} = 3.52$ cm.-assuming a rate of heat emission of
25.2 cals./hr.

1918

The authors use their value of Z to calculate the period of
radium, $Z = \lambda N$, whence $\lambda = 1.39 \times 10^{-11}$ sec.$^{-1} = 4.38 \times 10^{-4}$
years^{-1}, giving a period of half-transformation $T_{1/2} = 1580$
years.

357   Lind, S. C., Underwood, J. E., and Whittemore, C. F.
        "The Solubility of Pure Radium Sulfate." J. Am.
        Chem. Soc. 40, 465-72(1918).

The necessity for pptg. Ra and Ba together as sulfates at
some stage in any of the processes for recovering Ra from
its ores made desirable the detn. of the soly. of pure $RaSO_4$.
In order that the true satn. might be obtained with the greatest
accuracy, equil. was approached from both sides, i.e., soln.
made by dissolving pure $RaSO_4$ in solns. of N, 0.1 N and 0.01
N H_2SO_4 and in pure water, and by pptg. it from $RaBr_2$ soln.,
were prepd. and measured. $RaSO_4$ was detd. directly by the
emanation method for Ra itself. The soly. of pure $RaSO_4$ in
1 cc. H_2O at 25° is 2.1×10^{-6} g. or 1% of that of $BaSO_4$. Its
soly. in H_2SO_4 solns. from 0.01 N to 50% acid is identical
with that in H_2O, showing that the presence of acid produces
no repressive effect as might be expected. At higher concns.
of H_2SO_4 the soly. rises greatly and between 65 and 70% it
increases 12 fold.

358   McCoy, H. N. and Henderson, L. M. J. Am. Chem.
        Soc. 40, 1321-5(1918).

Two methods for the extraction of $MsTh_1$ (Ra^{228}) from
thorianite or Th itself, are given.

359   Meitner, L. Physik. Z. 19, 258(1918).

The author reports the half-life period of $MsTh_1$ (Ra^{228})
to be 6.7 years.

360   Schlesinger, W. A. (to the Radium Company of
        Colorado) U. S. Pat. 1,435,180 (1918).

A method for leaching carnotite with alkali-lye solns. is
described.

1919

361   Bleecker, W. F. (to the Tungsten Products Com-
        pany) U. S. Pat. 1,399,246 (1919).

A method for treating ores with Na_2CO_3 and water under
pressure for Ra recovery.

362   de Broglie, M. "Spectroscopy of X-rays. I. The
        "L" Absorption Spectrum of Radium." Compt.
        rend. 168, 854-5(1919).

It is comparatively simple to obtain the L absorption
spectrum of radium. The author has also obtained this
spectrum by placing a thin tube containing 1 mg. of solid
radium sulfate before the slit of the spectrograph. The
wave-length obtained, $\lambda = 0.659 \times 10^{-8}$ cm., assigns to Ra
the atomic number 88, in good agreement with the accepted
value.

363   Dorsey, N. E. "Graphical Method Applicable to
        Radium Measurements." Phys. Rev. (2) 14, 173
        (1919).

(Abstract of paper read before the Am. Phys. Soc., April,
1919.)

In the determination of the radium content of sealed speci-
mens that have not reached equilibrium it is very desirable

1919

to ascertain promptly the concordance of each observation
with those that have preceded it. A simple graphical method
used during several years past at the Bureau of Standards,
Washington, is described.

364   Kausch, O. Edel-Erden u. -Erze 1, 38-67(1919).
   Comprehensive treatment of the subject "removal of Ra
from ores". Various methods are described, and various
kinds of ores are treated. Adsorption (using MnO_2), fusion
and soln. methods are discussed. The use of NaOH, $NaHSO_4$,
Na_2CO_3, and H_2SO_4 in the recovery processes is treated.
The reduction of crude Ra-Ba sulfates using CaC_2 and CaH_2
is also described. The dialysis method for the removal of
ThX (Ra^{224}) from colloidal $Th(OH)_4$ is also discussed.

365   Lerch, F. "Slow Variations in the β-radiation from
         Radium Preparations." Sitzber. math.-naturw.
         Klasse Akad. Wiss. Wien 128, 2a, 635-8(1919).
   Discusses some apparent changes of β-activity observed
when radium preparations are treated chemically.

1920

366   Deniges, G. "Microchemical Reactions of Radium;
         Its Differentiation from Barium by Means of Iodic
         Acid." Compt. rend. 171, 633-5(1920).
   Procedure: Take two glass plates; place a droplet (2-4
mm. in diam. at the most) of $RaBr_2$ soln. containing about
3 parts per 1,000 on one, and a droplet of $BaBr_2$ of equiv.
strength on the other. At a very little distance from each
of these droplets place similar vols. of 10% iodic acid. Join
the drops, using a Pt wire. Feathery crystals of the mono-
clinic system are formed in both cases. They cannot be
distinguished one from the other even at great magnifica-
tions. If now, diln. is increased five- or even ten-fold, i.e.,
0.30 parts per 1,000, the crystals of the two salts are seen
to be entirely different. Drawings are given for the two dilu-
tions. The difference in crystal form suggests the study of
a new method of sepn. of Ba and Ra. A mg. of $RaBr_2$ was
used in the expts.

367   Johnstone, J. H. L. and Boltwood, B. B. "Relative
         Activity of Radium and Uranium with Which It Is in
         Radio-Active Equilibrium." Phil. Mag. (6), 40,
         50-67(1920).
   The relation of the activity of radium to the activity of the
uranium with which it is in radio-active equilibrium has
been re-determined. The results obtained indicate that if
the activity of uranium is taken as unity the activity of the
radium is equal to approximately 0.49.

368   Johnstone, J. H. L. and Boltwood, B. B. "Relative
         Activity of Radium and Uranium with Which It Is in
         Radio-Active Equilibrium." Am. J. Sci. 50, 1-19
         (1920).
   The relation of the activity of radium to the activity of
the uranium with which it is in radio-active equilibrium has
been re-determined. The results obtained indicate that if
the activity of uranium is taken as unity the activity of the
radium is equal to approximately 0.49.

369   Nierman, J. L. "Concentration of Radium and
         Mesothorium by Fractional Crystallization." J.
         Phys. Chem. 24, 192-200(1920).

1920

   The crystallization factor of mesothorium and radium in
bromide solutions was found to be independent of the concen-
tration of hydrobromic acid. A determination was made of
the crystallization factors corresponding to different per-
centages of crystals separating. For concentrations of
mesothorium up to 2 mg./g. of salt, the crystallization
factor remains constant. The separation of mesothorium
and radium from barium can be conducted advantageously
in neutral or dilute acid solutions of the bromides.

370   Scholl, C. E. "Crystallization of a Radium-Barium
         Solution." J. Am. Chem. Soc. 42, 889-96(1920).
   Ra of any degree of purity can be obtained by the fractional
crystn. of a Ra-Ba soln. The bromides offer a more efficient
system for crystn. than the chlorides. The concn. of Ra in
the crystals and in the mother liquor may be calcd. by the
simple formulas given, which involve the factor of enrich-
ment, K—the relative concn. of Ra in the crystals to Ra in
the original material. When K has certain definite values
the calcd. concns. of the different dishes give a complete
system of crystn., one which allows of the proper combining
of dishes. Several such systems are given with a modified
form, which is very efficient in the crystn. of high grade Ra.
The conditions of crystn. and some facts noticed during
crystn. are given. The formation of a salt, $RaBr_2$-$2BaBr_2$.
$6H_2O$, in crystals from slightly acid solns., is indicated.

1921

371   Curie, M. "The γ-Radiation and Liberation of
         Energy from Radium and Mesothorium." Compt.
         rend. 172, 1022-5(1921).
   Radium and mesothorium are isotopic elements which up
to the present have not been chemically separated. It is
difficult also to distinguish between these substances (in
equilibrium with their decay products) by measurement of
the penetrating powers of their γ-rays. But it is possible
to make the distinction by measurements of heat emission
due chiefly to the α-rays, from these substances. The author
makes a calculation of the difference to be expected and
shows the practical possibility of determining by this method
the amounts of Ra and MsTh in a mixture.

372   d'Aguiar, H. D. Met. Chem. Eng. 25, 825, 877,
         (1921).
   A method for the extraction of Ra from carnotite with
HNO_3 is described.

373   Ebler, E. and van Rhyn, A. J. Ber. 54, 2899-906
         (1921).
   An article on the separation of Ra-Ba salts by adsorption
with silicic acid which also includes information on the
pptn. of Ra salts using H_2SO_4.

374   Germann, F. E. E. "Adsorption of Radium by Barium
         Sulfate." J. Am. Chem. Soc. 43, 1615-21(1921).
   Standardized solns. of $RaCl_2$ were boiled with definite
amts. of $BaSO_4$. Ra remaining in soln. was detd. Kroeker's
law, Freundlich's law, and all adsorption laws which apply
to other substances hold.

375   Meitner, L. Z. Physik 4, 146 (1921).
   An article including data on the nuclear structure of the
radium atom.

1921

376   Owen, E. A. and Fage, W. E. "The Estimation of
       the Radium Content of Radioactive Luminous Com-
       pounds." Proc. Phys. Soc. (London) 34, 27-32
       (1921).

The radiation absorbed by the salt is added to that given
out to find the total Ra content of the compd. The Ra content
of the sample was measd. by the combined ionization chamber
and gold leaf chamber. The tube contg. the Ra was first
measd. The absorption of the activity by ZnS was measd. in
4 ways by the γ-ray method: (1) The sulfide was placed in a
cell between the Ra and the chamber. (2) The Ra tube was
placed on the axis of a tube contg. the sulfide and the Ra con-
tent measd. (3) The Ra salt was mixed with the sulfide and
the Ra content measd. (4) The Ra salt was mixed with the
sulfide as in (3), but a second tube contg. Ra was measd.
through the mixt. The absorption of γ-radiation was found
to be about the same as in ZnS. Four tables are given.
Table III gives the ratio of true content to the apparent
content. For a tube 3 cm. in diam. it is 1.13. Table IV
gives the absorption coeff. for several compds.

377   Pascal, P. Compt. rend. 173, 144(1921).
Observations on the magnetic susceptibility of Ra are
described.

378   Petit, G. "Radioactivity of Mesothorium and Its
       Derivatives." Presse med. 29, 203-41(1921).
A review of information on Ra^{228} and its decay products.

379   Simmersbach, B. Edel-Erden u.-Erze 2, 137-46
       (1921).
The fusing of radium ore with $NaHSO_4$ is discussed.

380   Strong, R. K. "The Isotopism of Mesothorium and
       Radium and the Separation of These Elements from
       Barium." J. Am. Chem. Soc. 43, 440-52(1921).
1100 g. of $BaCl_2$ containing 11 mg. of MsTh and 3 mg. of
Ra were prepd. from monazite residues. Concns. were made
by the McCoy hydroxide method and by the bromide method.
All concns. showed the same MsTh/Ra ratio. In this work a
large number of transformations and crystns. are made, but
the ratio does not change. This work furnishes further
evidence that MsTh and Ra are isotopic.

1922

381   Becker, A. "The Stability of Radium Solutions."
       Z. anorg. allgem. Chem. 124, 143-52(1922).
Standard $RaCl_2$ solns., contg. from 0.02115 to 0.00001897
mg. Ra/g., some HCl and a little $BaCl_2$, which had been used
in the analysis of pitchblende in 1914, were once more com-
pared with the same pitchblende in 1922. The Ra content
was found unchanged, on the assumption of const. Ra content
of the ore, within the working error (1%).

382   Bleecker, W. F. Chem. Zentr. II, 436(1922).
Experiments on the treatment of radium ore with Na_2CO_3
and water under pressure are described.

383   Bleecker, W. F. U. S. Pat. 1,478,631 (1922).
A method for the extraction of radium from carnotite
using H_2SO_4 and HF is described.

1922

384   Bohr, N. Z. Physik 9, 56(1922).
An article on the configuration of the electrons in the
radium atom.

385   Bothe, W. "Precautions Against Damage to and
       Loss of Radium Preparations." Edel-Erden u.
       -Erze 3, 37-8(1922).
B. makes a few remarks concerning the recovery of lost
Ra prepns. by means of a ZnS screen and an electroscope.

386   de Broglie, M. Les Rayons-X. Blanchard, Paris.
       1922.
X-ray wave length and absorption limits for Ra included.

387   Dorsey, N. E. "An Instrument for the Gamma-Ray
       Measurement of the Radium Content of Weakly
       Active Material." J. Optical Soc. Am. 6, 633-8
       (1922).
The author describes a modification of W. Bothe's method
of measuring the radium content of feebly radio-active
substances. It consists of a triple cylinder ionization chamber
attached to an electroscope, the active material being intro-
duced into the inner cylinder. It has distinct advantages over
Bothe's arrangement in the ease of manipulation. The sen-
sitivity of the instrument used by the author was about 2.8
divisions per second per milligram of radium. Specimens
of radium concentrates containing from 7 to 60 microgram
and small preparations containing as much as 300 micro-
gram of radium were satisfactorily measured to a precision
of at least 1%. Though the instrument is well suited to the
determination of the radium content of concentrates, it is
not suitable for work with low-grade ores. For such work a
more sensitive instrument or one utilizing a larger amount
of active material would be required.

388   Fleck, H. (to W. A. J. Bell). "Concentrating Radium
       Preparations." U. S. Pat. 1,588,383 (1922).
A Ra-Ba salt such as the sulfate, chloride or bromide is
dissolved by a solvent such as a hot oxalic acid soln., having
a relatively greater action on the Ra than on the Ba material.
The filtered soln. is then treated, e.g., by adding a small
quantity of H_2SO_4, to obtain a ppt. of higher Ra content than
the material originally treated.

389   Francis, A. G. "The Recovery of Radium from
       Luminous Paint." J. Soc. Chem. Ind. 41, 94-6T
       (1922).
Paint is roasted and Ra sepd. as $(Ra-Ba)SO_4$. This is
converted to chloride and Ra concd. by fractionation. Less
than 1% Ra loss and purification to 57% Ra is reported.

390   Geiger, H. Z. Physik 8, 54(1922).
ThX (Ra^{224}) emits only alpha rays. The range R of the
alpha rays at 0° and 15° respectively is $R_0 = 4.127$ cm.
$R_{15} = 4.354$ cm. The initial velocity is 1.543×10^9 cm/sec.
The initial energy is 5.603×10^6 V. The number of ion pairs
produced by one alpha particle is 1.77×10^5. The corre-
sponding values for AcX (Ra^{223}) are; $R_0 = 4.141$ cm., $R_{15} =$
4.364 cm., 1.64×10^9 cm./sec., 5.615×10^6 V., and $1.78 \times$
10^5.

1922

391   Hess, V. F. "A New Method of Determining the Radium Content of Carnotite Ores and Other Products of Low Activity." Trans. Am. Electrochem. Soc. 41, 287–301(1922).

When carnotite or other materials are filled into the space between two concentric cubes or spheres, the gamma-ray effect in the center of the inner cube or sphere can be calculated. This formula was taken as a basis of a direct method of determining the radium content of these substances. The samples were filled in wooden containers which were closed hermetically. The gamma-ray electrometer was introduced into the center. The observed ionization, expressed in absolute units (e.s.u.) reduced to normal pressure and temperature, multiplied by certain constants, gives directly the radium content per gram of material. The method is sensitive enough to give correct figures for material with 10^{-10} g. radium per gram of material. It is very simple, and requires no chemical treatment of the samples before the measurements. The results on ore samples were compared with the results derived from the chemical analysis of the uranium content, and were found to be in good agreement.

392   Hess, V. F. and Damon, E. E. "Determination of the Radium Content of Low-Grade Radium-Barium Salts." Phys. Rev. (2), 20, 59–64(1922).

Because of absorption of the rays by the salt, the present gamma-ray method is rather inaccurate for concentrations less than 10^{-5}, and for concentrations above 10^{-7} the emanation method is too sensitive. To bridge the gap, the authors have modified the first method by adopting a shallow container with two curved sides, each concentric with the cylindrical string electrometer used to measure the rays, and only a small fraction of the radius apart. This shape has the effect of making the mean absorption due to the salt small and also very nearly equal to half the maximum absorption. The procedure is to take readings with the container in position (full of the salt to be measured) first alone, then with a small radium tube of known strength placed first just in front and then just behind the container. The ratio of the first reading to the mean of the other two gives the ratio of the strength of the unknown to the sum of the strengths of the known and unknown within one per cent. The method is both quicker and more accurate than the emanation method for concentrations between 10^{-5} and 10^{-7}. The container used was made of tin plate and was $10 \times 10 \times 2$ cm., the radii being 30 and 32 cm.

393   Lemay, P. and Jaloustre, L. Compt. rend. 173, 916(1922).

The action of Ra salts as catalysts in some oxidation processes is described.

394   Meitner, L. Z. Physik 9, 142(1922).

An article on the β-rays emitted by Ra.

395   Owen, E. A. and Naylor, B. "The Measurement of the Radium Content of Sealed Metal Tubes." Proc. Phys. Soc. (London) 34, 92–7(1922).

Tables have been compiled giving the corrections that have to be applied to the observed radium content of sealed platinum and silver tubes to obtain their true radium content. Two

1922

cases have been considered, (1) that in which the active deposit is uniformly distributed throughout the volume of the tube such as in a full tube of salt, and (2) that in which the active deposit is uniformly distributed over the inner wall of the tube, such as in a tube containing a minute quantity of highly concentrated salt. The results show that when the wall thickness is kept constant, the correction increases with the external diam. of the tube. Also for the same increase of external diam., the increase of correction is more pronounced for the "empty" than for the full tube.

396   Pietenpol, W. B. "Relative Deposition of Radium and Barium Salts as a Function of Temperature and Acidity." Phys. Rev. (2), 20, 199(1922).

The first crystals formed in cooling a soln. of Ra and Ba salts as in the commercial refining of Ra contain a larger percentage of Ra than the succeeding crystals. It is pointed out that the efficiency of the refining process may be increased by sepg. liquor and crystals above room temp. With rapid cooling a smaller per cent of Ra is adsorbed than with slow cooling.

397   Rinne, F. Z. physik. Chem. 100, 412(1922).

The author reports that $RaCl_2 \cdot 2H_2O$ is isomorphous with $BaCl_2 \cdot 2H_2O$.

398   Szilard, B. "The Direct Determination of Very Small Quantities of Radium by Penetrating Rays." Compt. rend. 174, 1695–8(1922).

S. describes a portable electrometer, having a flexible sensitivity. The charger consists of an ebonite rod, which rotates against a brush of hair. The sensibility is varied by altering the eccentricity of the fixed quadrant of the electrometer, with respect to the movable quadrant. The instrument is especially useful for field examn. of rocks. One division on the micrometer scale represents a current of 10^{-4} e.s.u., which would be produced by placing 0.001 g. of U_3O_8 in the app. Analysis of 500 g. of rock containing 10^{-9} g. of Ra was accurate to 2.5 .

399   Yovanovitch, D. K. "The Chemical Properties of Mesothorium 2." Compt. rend. 175, 307–09(1922).

Starting with a hot concd. soln. of $BaCl_2$, contg. $MsTh_1$ (Ra^{228}) and Ra, these 3 substances were pptd. by means of HCl (concd.). This left $MsTh_2$, Radio-Th, and active deposit in soln. The Ac isotope was pptd. with salts of various rare earths as the hydroxide while the Th remained in soln. A study of the chem. properties of the $MsTh_2$ (Ac^{228}) disclosed a very close relation to La.

400   Yovanovitch, D. K. and Chamié, C. "Preparation of a Standard Radiferous Salt." Compt. rend. 175, 266–8(1922).

The preparation of a radio-active standard solution for the determination of the relatively small amounts of radium in minerals is not easy owing to the tendency towards formation of insoluble deposits from the solution. The attempt is here recorded for the preparation of a solid standard. Radiferous barium chloride was first tested, but found unsatisfactory, and recourse was had to the insoluble and non-hygroscopic carbonate. Methods for the preparation of the latter are included, with an illustrative diagram of the ap-

1922

paratus employed. Data are given showing that a standard content of radium can be secured by the method described to 0.5%.

1923

401 Barker, H. H. and Schlundt, H. "Extraction and Recovery of Radium from Typical American Carnotite Ores." Missouri Univ. School Mines and Met. Bull. 24, 3-87(1923).

The methods used for the extraction of radium from uranium ores are grouped under the three headings; (1) direct solution by means of acids, with or without preliminary conversion of the radium and barium into carbonates; (2) concentration of the radium by reduction of the gangue material; and (3) miscellaneous processes. These are discussed in detail, and their advantages, disadvantages, and conditions of application indicated. For control work in plant operations and for the measurement of radium in general three standard methods are used: the emanation, gamma-ray, and alpha-ray methods. The application of these methods to the case of carnotite ores, and the chemical treatment involved in the latter are described in detail. A new method for charging electroscopes, due to le Roy and Schlundt, consists in transforming an ordinary lighting circuit voltage, say 110 volts, to 3000 volts, rectifying this by means of a "kenotron" rectifying tube, and using a special high-resistant potentiometer to secure any potential required to charge the leaf system of the electroscope to the desired degree.

402 Baumgarten, C. E. and Barker, H. H. "The Quantitative Estimation of Radium by the Emanation Method." Ind. Eng. Chem. 15, 597-9(1923).

A phosphoric acid method for the detn. of Ra by the emanation method is described. The method is similar to Barker's bisulfate method. It is also shown that mixts. of HNO_3 and H_2SO_4 and of HNO_3 and H_3PO_4 may be used. B. prefers the H_3PO_4 method.

403 Bohr, N. Naturwissenschaften 11, 619(1923).

An article on the configuration of the electrons in the radium atom.

404 Bohr, N. and Coster, D. Z. Physik 12, 344(1923).

An article on the configuration of the electrons in the radium atom.

405 Cialdea, U. "Separation of Radium from Other Elements." Gazz. chim. ital. 53, 42-8(1923).

This is an account of the recovery and purification of $RaBr_2$ accidentally spilled on a pavement and of the observations made in the process. The method used was an adaptation of the process used by Debierne in sepg. Ra from its ores.

406 de Broglie, M. and Cabrera, J. "On the Gamma Radiations of the Radium and Thorium Series Studied by their Photoelectric Effect." Compt. rend. 176, 295-6(1923).

By irradiating different substances with γ-radiation from radium and mesothorium, and studying the β-radiation emitted with the apparatus described in a previous paper, the authors have arrived at the wave-lengths of some of the lines

1923

in the γ-ray spectra of the radium and thorium series. The values of the wave-lengths of the five lines which were obtained with radium are 51.9, 42.6, 35.6, 30.2, and 20.6×10^{-11} cm. Those of the five lines observed with mesothorium are 171.0, 59.7, 53.0, 37.0, and 29.7×10^{-11} cm. The longest wave-length in the thorium series corresponds to an electron from the L ring. All the other lines both in the radium and the thorium series correspond to K electrons. The values of the wave-lengths in the radium series agree well with those previously published by Ellis.

407 Khlopin, V. G. "The Separation of Radium and Barium." Bull. soc. chim. France 33, 1547-51 (1923).

A method used commercially in Russia for sepg. Ra and Ba is to pass HCl gas into a soln. of Ra and Ba chlorides. The chief advantages are that this method does not require the usual preliminary purification of the chlorides and the evapn. of solns. is eliminated.

408 Rosenbloom, J. "A Study of the Effects of Radium on Metabolism." J. Metabolic Research 4, 75-88 (1923).

Intravenous injection of 100 micrograms of Ra in dogs produced an increase in the N, the total S and the neutral S excretion maintained over 3 days. The excretion of creatinine and of uric acid was not affected. Local application of 16 micrograms for 4 days and 70 micrograms for 4 days was studied in a case of carcinoma. There was a N retention of 1.4 g., S of 0.5 g., CaO of 0.27 g., MgO of 0.29 g., and P of 0.8 g. The analytical picture of the urine was normal.

409 Schlesinger, W. A. Chem. Zentr. II, 239(1923).

Experiments with the leaching of carnotite with alkali-lye mixtures described.

410 Thews, K. B. and Heinle, F. J. J. Ind. Eng. Chem. 15, 1159(1923).

Experiments on the treatment of radium ore with Na_2CO_3 and K_2CO_3 are described.

411 Ulrich, C. "The Production of Radioactive Substances." Z. angew. Chem. 36, 41-2, 49-52, 54-5 (1923).

The extraction of Ra from pitchblende using H_2SO_4 and HNO_3; the redn. of the crude sulfate with C, CaC_2, and CaH_2; the use of NaOH in the sepn. of Ra from low-grade ores; and the sepn. of Ra-Ba chlorides by MnO_2 adsn. Information on the preparation of $RaCl_2 \cdot 2H_2O$ from $RaCO_3$ using conc. HCl, or from $RaBr_2$ using repeated evaporation with HCl is given.

412 von Hevesy, G. and Paneth, F. Lehrbuch der Radioaktivitat. Leipzig, Barth. 1923.

On pages 166-88 and 206-7 the effects and characteristics of radium rays are described. Extensive references.

1924

413 Bleecker, W. F. Chem. Zentr. I, 1849(1924).

An article on the extraction of radium from carnotite with H_2SO_4 and HF.

1924

414   Bothe, W. "The Estimation of Radium, Mesothorium and Radiothorium in a Mixture by Means of γ-Rays." Z. Physik 24, 10-19(1924).

The method employed, which takes advantage of the different coefficients of absorption of the γ-rays of these elements when sent through a lead filter, has been used by Hahn, who employed filters up to 4.5 cm. thick. The author has improved the experimental conditions by employing a series of much thicker filters and a very sensitive measuring device, with which the γ-rays penetrating through them can be measured. A series of four concentric lead cylinders was used, in the common axis of which the radioactive preparation was placed, the total possible thickness of lead being 11 cm. The ionization chamber was a cylindrical ring-shaped vessel surrounding the lead cylinders, and had a ring-shaped electrode of sheet iron concentric with the walls of the chamber. Curves were obtained for a number of different preparations, showing the radium equivalent, A, as a function of the filter thickness, by measuring for each thickness the velocity of fall of the gold-leak of the electroscope, first for the preparation and then for a normal radium preparation, the normal value of which through 0.5 cm. of lead was taken as unity. Curves are given for pure radium, pure radiothorium, old mesothorium preparations containing radium (in which a considerable amount of RaTh has formed), fresh mesothorium preparations separated from the old preparations containing a great deal of radium, and one containing very little radium; finally a curve is deduced for pure mesothorium from the above, and another for a mixture of the three substances, in which for three different thicknesses the radium equivalent is unity, but which rises above the pure radium line, drops below it, and then again rises above it as the thickness goes on increasing. The curve for each of the pure substances is so distinctive that, with very few exceptions, it is possible from the form of curve of a mixture to deduce the proportions of the three constituents.

415   Gaschler, A. "Production of Radium, Mesothorium, Uranium X and Thorium X from Uranium or Thorium and Gold from Mercury." Brit. 239,509, Sept. 4, 1924.

Transformation of metals are stated to be effected by subjecting small quantities of the metal in a vaporizing chamber to high pressure and temp. and submitting the metal vapor to the effect of a strong (preferably direct) elec. current.

416   Geiger, H. Verhandl. deut. physik. Ges. (3), 5, 12 (1924).

The author reports that the number of α-particles emitted per second by 1 g. or Ra is 3.48×10^{10}.

417   Geiger, H. and Werner, A. "Number of α-Particles Emitted from Radium. Part I. Scintillation Method." Z. Physik. 21, 187-203(1924).

Rutherford and Geiger, by an ionization by collision method, recorded the α-particles emitted from a known quantity of radium. The number finally given was 3.57×10^{10} α-particles/ g. of Ra/sec. Ten years later Hess and Lawson redetermined this constant and obtained a value $(3.72 \pm 0.02) \times 10^{10}$. On account of the fundamental importance of this radio-active constant, since it controls the life and heat emission of

1924

radium, the authors have undertaken a redetermination by more refined methods. In the first method employed by them, and now described, the α-particles are counted by a scintillation method, and a value 3.40×10^{10} α-particles/g. Ra/sec. is obtained. Using this value, the half-value period of radium is given as 1730 years; the helium emission as 159 mm.^{3}/year/g. Ra in equilibrium with Em + A + C'; the heat emission of Ra (free from its products of decay) 22.25 cal./hour/g. It is also calculated that the velocity of the α-particles from Ra is 1.511×10^9 cm./sec. in good agreement with observation.

418   Germann, F. E. E. "The Emanation Method for Radium." Science 59, 340-1(1924).

In using the emanation method, as developed by Schlundt and Moore, and by Lind, in radium analyses, or calibrating a β-ray electroscope, it is best to draw out and seal the neck of the flask, and not to use a rubber stopper or rubber tubing; the tip must be broken off after the flask has been connected, by means of tubing, to the emanation gas burette, but the small piece of glass broken off frequently lodges in the lower stop cock of the burette, and spoils the experiment. Three forms of trap are described which prevent this; in the simplest and most effective of these the flask is connected by rubber tubing to a short length of tube which slopes upward to join the horizontal tube leading to the burette, at an angle somewhat less than 90°; the inclined tube is prolonged a few millimeters past the joint, forming a tiny hemispherical trap, into which the glass tip may be projected, and fall back again, without lodging in the horizontal tube.

419   Hahn, O. Radium. German Pat. 472,857 (1924).

Stable Ra prepns. with high emanating properties are prepd. by treating Ra salt solns. with soln. of substances which, with a common pptg. agent, give a ppt. with a greater surface. Thus, $RaBr_2$ is mixed with $La(NO_3)_3$ and HF added. The RaF_2 produced is stable and of good emanating quality. $FeCl_2$ and $RaBr_2$ may be pptd. with NH_4OH. Other examples are given.

420   Hahn, O. and Meitner, L. "The β-ray Spectrum of Radium and Its Meaning." Z. Physik 26, 161-8(1924).

High-grade Ra is pptd. as carbonate upon a Pt wire so that only 0.1% of Rn is occluded. The carbonate is then baked so that its emanating power is nil. With this line source of radiation, the β-ray spectrum of Ra was photographed. Ra emits 3 lines whose Hp values are 1037, 1508, and 1575, corresponding to the K, L and M levels of the decompg. Ra atom, resp. The β-rays are excited by Kernel γ-rays accompanying the α-ray transformation and having a wave length of 6.6×10^{-10} cm.

421   Hess, V. F. and Lawson, R. W. "The Number of α-Particles Ejected by Radium." Phil. Mag. (6), 48, 200-07(1924).

The authors criticize the results of Geiger and Werner, and conclude that the larger number obtained by the present authors in 1918 is more reliable. The method of arriving at the true number of scintillations from the observations of three observers is also criticized. Replying to a remark of Geiger and Werner, the authors call attention to the fact that their own final result is not deduced from the photo-

graphic registration, as Geiger and Werner assume, but from numerous subjective counts.

422   Hess, V. F. and Lawson, R. W. "The Number of α-Particles Ejected by Radium." Z. Physik 24, 402-10(1924).

This article is similar to the previous reference.

423   le Bel, J. H. "Small Variations of the Heat Given Off by Radium Bromide." Compt. rend. 179, 160-1(1924).

In measuring the heat produced by different samples of radium, the author has found certain irregularities in the deflection of the galvanometer connected with the thermo-couple; this was in general, for the samples employed, about 40 cm., but once or twice a month it diminished by 10 to 15 mm. The second sample behaved like the first, the times of the minima coinciding. The walls of the cellar in which the experiments were made showed no signs of radioactivity.

424   Ludewig, P. "The Determination of the Radium Content of Weakly Active Substances by the Total Radiation Method." Z. Physik 20, 394-7(1924).

A Wulf doubled-leaf electroscope of small capacity is used to measure the penetrating radiation from Ra prepns. or ores which are inclosed in shallow containers, placed directly underneath it. The floor of the electroscope is of Zn 3 mm. thick. An additional screen of brass 3 mm. thick allows only penetrating radiation to enter the ionization chamber. The arrangement is particularly adapted to measurement of high-grade pitchblende.

425   Rodman, J. A. "The Effect of Temperature on the Luminosity of Radium Compounds." Phys. Rev. (2), 23, 478-87(1924).

Investigations were made with pure $RaBr_2$ and with mixts. of $RaBr_2$ and $BaBr_2$. The intensity of luminosity of a $RaBr_2$ capsule heated to 600° decreases according to an exponential law. Equil. was reached after 500 hrs. The initial luminosity of mixts. of $RaBr_2$ and $BaBr_2$ after removing from the furnace increases exponentially with the temp. In all cases the compn. and temp. det. the equil. value. The results are consistent with Rutherford's theory of "active centers." R. concludes that the active centers are formed on the absorption of heat energy, and that high temps. followed by rapid cooling favor their formation.

426   Stuner, E. C. Phil. Mag. (6), 48, 719(1924)

An article on the configuration of the electrons in the radium atom.

427   Thews, K. B. and Heinle, F. J. Chem. Zentr. I, 951(1924).

Experiments on the treatment of radium ore with Na_2CO_3 and K_2CO_3 are reported.

428   Todt, F. "The Electrolytic Separation of Non-Noble Radio Elements." Z. physik. Chem. 113, 329-35(1924).

The electrolytic methods employed by von Baeyer, and by Hahn and Meitner, for depositing these elements on a platinum wire have been investigated in the cases of radium and its isotopes (ThX and AcX), thorium and its isotopes,

actinium and mesothorium II. ThX (Ra^{224}) was specially dealt with; when much calcium was present a minute quantity of barium was added to act as carrier for the ThX, and was precipitated with chromic acid, the calcium remaining in solution; the chromate precipitate was dissolved in HCl, and deposited electrolytically with a small excess of acid, a stream of CO_2 being passed through the liquid, and a high current density employed. In this way the precipitation of carbonate is confined to a narrow alkaline zone close to the cathode, on which the precipitate settles. Thorium in weakly acid solutions, precipitates, when electrolyzed, in thick flakes of thorium hydroxide, owing to the OH^- ions left behind when H_2 is produced at the cathode; these flakes do not in general form a solid layer on the cathode. To get over this difficulty a strongly acid solution is necessary, so that the alkaline zone is reduced to a diffusion layer of 20-50 μ in thickness. The excess of H^+ ions up to this layer prevents a premature production of flakes, since positive colloids, such as $Th(OH)_4$, are peptized by H^+. It is shown that in the case of mesothorium II also the deposition is due to precipitation at the cathode, and that here, as in the other cases, the current only affects matters by bringing the necessary ions to the electrode.

1925

429   Bashilov, I. Y. Radium Salts. British Pat. 254,539 (1925).

Fractional sepn. of Ra and Ba salts is effected by repeatedly adding a salt having the same anion to the acid or neutral soln. of the salts so as to ppt. crystals having different activities; e.g., $CaCl_2$ or $AlCl_3$ may be added to soln. of Ra and Ba chlorides. An app. is described.

430   Bashilov, I. Y. Separation of Salts of Radium and Barium. German Pat. 515,681 (1925).

Same as Russian Patent 5046.

431   Briggs, G. H. Phil. Mag. (6), 50, 600(1925).

The sepn. of ThX (Ra^{224}) from RdTh (Th^{228}) by the recoil method is described.

432   Curie, M. Le Radium et les Radio-Éléments. Paris, Baillière. 1925.

Summary and review.

433   Curie, M. and Yovanovitch, D. K. "The Increase in the Heat Produced by Radium Salts due to the Formation of Polonium." J. Phys. Radium 6, 33-5 (1925).

The heat evolved by a radium salt, prepared in August 1907, was compared with that of a recent preparation, the amounts of radium being compared by means of measurements of the γ-rays given out from RaC contained in them. The heat per gram of radium had increased in 16.75 years by 11%, and this was due to the formation of polonium. The authors conclude that this formation has proceeded in a normal manner in $RaCl_2$.

434   Doerner, H. A. and Hoskins, Wm. M. "Coprecipitation of Radium and Barium Sulfates." J. Am. Chem. Soc. 47, 662-75(1925).

1925

In the presence of a large excess of Ba over Ra, sulfate ions will ppt. Ra even though the soly. product of $RaSO_4$ is not exceeded. Postulating that the Ra/Ba ratio in the surface of a ppt. is proportional to the Ra/Ba ratio in soln. for each successive stage of pptn., the distribution of Ra and Ba after partial pptn. is given by the equation: Log $[(Ra^{++}$ (final))/$(Ra^{++}$ (initial))] = K log $[(Ba^{++}$ (final))/$(Ba^{++}$ (initial))]. Exptl. data from a quant. study of the reaction of a Ra-Ba chloride soln. with (a) H_2SO_4 and (b) $BaSO_4$ support this equation. K is approx. 1.8. Application of this equation to adsorption and fractional crystn. is discussed. [On page 675 in the summary the equation should read as above.--Abstr.]

435   Hahn, O. "Die Reaktiven Substanzen und ihre Eigenschaften." In Meyer, H. Lehrbuch der Strahlentherapie, Berlin, 1925
In vol. 1, p. 455 the rays emitted by $MsTh_1$ (Ra^{228}) and $MsTh_2$ (Ac^{228}) are described.

436   Khlopin, V. "Fractional Crystallization of Radioactive Compounds, Together with an Attempt for a Theory of These Processes. I." Z. anorg. allgem. Chem. 143, 97-117(1925).
An increase in the concn. of the anion can be used for the fractional crystn. of Ba-Ra salts instead of evapn. The fractional pptn. of the chloride by aq. HCl has been worked out on a com. scale. The distribution of the Ra between solid and liquid phases follows the Berthelot-Nernst distribution law as a first approximation. The value of the concn. coeff. is variable after partial pptn. or partial soln.

437   Kovarik, A. F. and McKeehan, L. W. Bull. Nat. Research Council (U.S.) 10, No. 51, (1925).
The rays emitted by radium are described.

438   Landé, A. Naturwissenschaften 13, 604(1925).
An article on the configuration of the electrons in the radium atom.

439   Lattes, J. S. "The Decomposition of the Total Rays of Radium into Definite Groups by Absorption in Platinum." Compt. rend. 180, 1023-6(1925).
From a tube contg. 65 mg. of Ra element sealed up in 1907 in a glass tube about 0.5 mm. thick, the rays were analyzed by absorption in Pt into the following groups: Primary γ-rays--3 groups; primary β-rays--4 groups; secondary β-rays produced by γ-rays--3 groups; secondary γ-rays produced by β-rays--too weak to analyze.

440   Lawson, R. W. "Energy Liberated by Radium." Nature 116, 897-8(1925).
The total heat development of 1 g. of Ra, free from its disintegration products, is calcd. to be 23.28 or 25.47 cal./hr., according as the no. of atoms of Ra disintegrating/sec./g. of the element is taken to be 3.40 or 3.72×10^{10}, resp. Hess's exptl. value is 25.2 cal./hr., but when cognizance is taken of the amt. of γ-radiation unabsorbed under the exptl. conditions employed, it is computed that the corrected value cannot greatly differ from 25.5 cal./hr. Support is thus given to the essential correctness of the value $Z = 3.72 \times 10^{10}$, in harmony with Kovarik's work. The data employed in the calcns. are quoted.

1925

441   Martland, H. S., Conlon, P., and Knef, J. P. "Some Unrecognized Dangers in the Use of and the Handling of Radioactive Substances, with Especial Reference to the Storage of Insoluble Products of Radium and Mesothorium in the Reticulo-Endothelial System." J. Am. Med. Assoc. 85, 1769-76(1925).
The cases described represent a hitherto unrecognized form of occupational poisoning. The anemias encountered are proved to be due to the ingestion of radioactive elements with the deposition of insol. fixed particles in the phagocytic cells of the sinusoids of the reticulo-endothelial system, where they continuously emit irritative rays, which in time produce exhaustion of the adjacent hematopoietic center.

442   Sale, J. W. "Report on Radioactivity of Drugs and Water." J. Assoc. Official Agr. Chemists 8, 531-5 (1925).
Description of U.S. Bureau of Chem. method for determining Ra in solns. by emanation method. Apparatus diagram, standardization methods, and 11 item bibliography are included.

443   Sommerfeld, A. Physik. Z. 26, 70(1925).
An article on the configuration of the electrons in the radium atom.

444   Swinne, R. Z. Elektrochem. 31, 417(1925).
An article on the configuration of the electrons in the radium atom.

445   Williams, G. O. Radium Compounds. U.S. Pat. 1,554,056 (1925).
In pptg. Ra from an alkali-metal carbonate soln., the soln. is acidified with H_2SO_4, a sol. Ba salt such as $BaCl_2$ is added, the ppt. is dissolved in concd. H_2SO_4, and, after filtering, H_2O is added to the soln. until Ra-Ba sulfate is repptd.

1926

446   Backhurst, I. "Obliquity Corrections in Radium Estimation." Proc. Phys. Soc. (London) 38, 277-90 (1926).
Formulas are given for obliquity corrections in Ra estn. applicable in the following cases: (1) Point source; (2) uniform line source; (3) uniform rectangular laminar source perpendicular to OC; (4) uniform square laminar source centrally placed perpendicular to OC; (5) uniform circular disk source in a plane perpendicular to OC; (6) uniform cylindrical source, axis cutting OC at right angles; (7) short uniform cylindrical source, axis coinciding with OC; (8) uniform source in the form of a short prism of square section, axis coinciding with OC; (9 and 10) as in (7) and (8), with correction for absorption in the source included. OC is the axis (produced) of the ionization chamber, assumed cylindrical in form. Exptl. results show that the effect of scattering is much more marked than that indicated by theory.

447   Brancati, R. "Experimental Production of Rare Tumors by Stimulation (tar and radium)." Bull. Atti Accad. Med. Roma (2), 52, 47-52(1926).

1926

By injection of a tar-oil mixture into the peritoneal cavity of a mouse, an infiltrating lymphoma arising from the mesentery and invading the mediastinum was produced. In another mouse a spindle-cell sarcoma was produced transplantable for 5 generations, retaining the same histological characteristics. In a rat, a tube containing 1 mg. radium was left for 70 days under the skin. From the margin of the subsequently developing ulcer arose a polymorphous cell sarcoma which grew to the size of a hen's egg. Pathogenesis is explained by chemical and chemico-physical stimulation with destruction and regeneration of tissues and passage from hyperplasia to neoplasia.

448   Briggs, G. H. Proc. Cambridge Phil. Soc. 23, 73 (1926).
The separation of ThX (Ra²²⁴) from RdTh by the recoil method is described.

449   Cave, H. M. and Gray, J. A. "The Scattering and Absorption of the γ-Rays of Radium." Phys. Rev. (2), 27, 103(1926).
γ-Rays filtered through 2 cm. of Pb have a mass scattering coeff. equal to $0.102Z/A$, where Z is the At. No. and A the At. Wt. of the material used. $(\mu/p)_{Pb}$ is 0.053. γ-Rays for which $(\mu/p)_{Pb}$ is 0.0475 have been isolated. The distribution of the radiation scattered from paraffin wax has been detd. The results indicate that γ-rays filtered through 2 cm. of Pb have an effective wave length in the neighborhood of 0.012 Å.

450   Colwell, H. A. and Wakeley, C. P. G. An Introduction to the Study of X-Rays and Radium. London, Oxford Medical Press. 1926. 203p.
This volume is to serve as an introduction to the subject for students of elementary physics and medicine. The first 4 chapters deal with the discovery, nature, and dangers of x-rays, with the methods of x-ray examinations. The remaining 8 chapters concern radium and include a history of the development of our knowledge of the subject, preparation of radium, preparation and measurement of radium emanation, action of radium upon normal tissue, therapeutic uses of x-rays and radium, facts and theories concerning the modes of action of radiations upon living tissue, the atomic theory, and the present conception of the structure of the atom. Appendices give units of measurement.

451   Daels, F. and G. Bacten. "A Note on the Different Kinds of Malignant Tumors Experimentally Obtained by Means of Radium." Lancet 211, 666-9 (1926).

452   Dufton, A. F. "Measurement of Radium During Radioactive Growth." Brit. J. Radiology 22, 128-9 (1926).
Illustrates a nomogram for computing the γ-ray activity of a radioactive prepn. with respect to time.

453   Dufton, A. F. "The Measurement of Low Grade Radium Preparations." Brit. J. Radiology 22, 157-9(1926).
Von Schweidler has expressed the ratio of the observed intensity of a low grade radium preparation in the form of a mathematical series. The author develops on mathematical grounds a more convenient approximate formula.

1926

454   Eliseev, A. G. "The Separation of Pure Radium Salts from Isomorphous Mixtures with Barium." Ann. inst. anal. phys. chim. (USSR) 3, 443-54(1926).
Soly. isotherm (at 25°) of BaCl₂ in water + HCl shows no complex formation, the soly. being 30.7 g. per 100 g. of H₂O and approaching 0 in 28% HCl. A study of the system RaCl₂-BaCl₂-HCl-H₂O shows that the soly. of RaCl₂ at first decreases more rapidly than that of BaCl₂; RaCl₂ does not influence the soly. of the Ba salt. The soln. was at no point satd. with respect to RaCl₂; the latter seps. by forming isomorphous crystals with BaCl₂. The enrichment factor is 2.8 at the beginning of pptn. with HCl and approaches 1 asymptotically.

455   Fernau, A.   Physics and Chemistry of Radium and Mesothorium.   Vienna, Springer, 1926. 101p.

456   Fleck, H. Chem. Zentr. II, 1173(1926).
A method for the separation of radium salt from mixed barium and radium salts with oxalic acid.

457   Flinn, F. B. "Radioactive Material and Industrial Hazard?" J. Am. Med. Assoc. 87, 2078-81(1926).
Five deaths from jaw necrosis among employees of 1 plant using luminous paint lead to an investigation of the whole industry. Over ⅔ of the employees working were examined, but no other cases were discovered in America, nor did an inquiry in Europe reveal any. This jaw necrosis differs from the ordinary necrosis, being of a gelatinous nature, occurring in separated areas in the mouth, and usually developing after some dental intervention. These necrostic areas heal but recur. It is supposed that the condition was caused by the employees pointing the brushes between their lips. The luminous material consisted of ZnS with minute quantities of Cu, Mn, Cd, radium or mesothorium. Studies were made of the amount of material an employee might ingest in a day and its elimination from the body. The examination consisted of inspecting the oral cavity, blood examination, and testing for radioactive deposits in the body by means of the alpha and gamma ray electroscope. The writer considers that further studies are necessary to prove that radium or mesothorium causes the necrosis.

458   Geiger, H. and Scheel, K. Handbuch der Physik Berlin. 1926.
In vol. 22, p. 128 there is a discussion on the nuclear structure of the radium atom.

459   Hahn, O. and Heidenhain, J. "Radium Preparations with High Emanating Power." Ber. 56, 284-94(1926).
The emanating power (E.P.) is defined as the ratio of the amt. of emanation diffusing out of the prepn. at room temp. to that actually produced by the radioactive substance present. The E.P. is much greater for amorphous than for cryst. prepns. LaF₂, from 10% La(AcO)₂ soln. and HF, with 4×10^{-5} Ba and 10^{-9} Ra per cc. gave prepns. of E.P. 69.6, 65 and 63% after 3, 6 and 12 months, resp., Fe₂(CO₃)₃ from FeCl₃, RaBr₂, NH₃ and (NH₄)₂CO₃, gave E.P. 99.5%, decreasing only slightly with time.

460   Kendall, J., Jette, E. R., and West, W. "The Separation of Radium and Mesothorium I from Barium by

1926

the Ionic Migration Method.'' J. Am. Chem. Soc. 48, 3114-17(1926).

The application of the ionic-migration method to the sepn. of Ra and MsTh₁ (Ra²²⁸) from Ba is investigated. It is shown that the mobility of these radioactive ions exceeds that of Ba to a sufficient degree to permit a practicable sepn. of Ra, MsTh₁, or mixts. of the 2 from Ba. In a typical run the activity per unit weight of the front segment (after traveling a distance of 500 cm. in 8 days) is 1031: the activity of the rear segment is 99; and the activity of an unmigrated sample is 333.

461 Martland, H. S. ''Microscopic Changes of Certain Anemias Due to Radioactivity.'' Arch. Path. Lab. Med. 2, 465-72(1926).

The author reports the autopsy, histologic and toxicologic examinations of a girl whose disease had during life been diagnosed as a leucopenic regenerative anemia due to occupational radium and mesothorium poisoning. She had worked 7 yrs. painting watch dials with luminous paint, pointing the brush tips with her lips. A chronic leucopenic anemia developed with extensive necrosis of the inferior maxilla. Morphology of the blood during life closely resembled pernicious anemia with the important exception that there was very little evidence of increased hemolysis, the icteric index and van den Bergh tests were negative. Autopsy showed a profound anemia characterized by intense replacement of the normal adult fatty marrow by red regenerating marrow. Histologically there was regeneration of the megaloblastic type. In the marrow, spleen, liver, heart, and kidneys hemosiderin deposits were either absent entirely or present only in very small amounts. Organs after incineration were tested for radioactivity and the greatest amount was found in the bones, a very minute amount being found in the spleen, liver, and gastrointestinal tract, and none in other organs. After chemical extraction it was estimated that the entire skeleton contained about 150 micrograms of radioactive substances, around 70% being mesothorium. The amount of radioactive substances in the bones when placed against photographic plates showed distinct photographic impressions after 7-18 days exposure. By the technic of Lacassagne autohistoradiographies were obtained from paraffin blocks of the tissue from the jaw and femur. The investigations confirm previous work of the author and his coworkers in describing this unusual form of occupational poisoning.

462 Meyer, S. and von Schweidler, E. Radioaktivitat. 2ed. Berlin, Springer 1926.

In vol. 22, p. 278 the reduction of crude RaSO₄ with carbon is described.

463 Pearse, H. E. ''The Effect of Lead and Radium on Mature and Immature Red Blood Corpuscles.'' Arch. Internal Med. 37, 715-24(1926).

Control tests confirm the work of others that erythrocytes following chronic blood loss, on standing several hrs. in Ringer's solution, and after exposure to P and Cl₂ have an increased resistance to hemolysis by hypotonic saline solutions. Lead produces a greater increased resistance of mature than immature red blood corpuscles. Irradiation with radium emanation does not change this resistance. Lead and radium combined produce an effect midway between the effect of either alone. Radium hemolyzes more

1926

readily immature than mature red blood corpuscles, while lead has the opposite effect. Irradiation of ''leaded'' erythrocytes greatly increases the amount of hemolysis above that produced by either agent alone. This effect is twice as great on immature as on mature red blood corpuscles.

1927

464 Bashilov, I. Y. ''Recovery of Radium from Old Luminous Paints.'' J. Chem. Ind. (Moscow) 4, 425-7 (1927).

Luminous paints consisting of ZnS, which has been calcined at 1000-1300° for its transformation into a cryst. modification, and a very slight addn. (50-250 mg. per kg.) of Ra salt lose their luminosity in the course of time, but their Ra content remains practically unchanged and can be recovered. A method for the recovery of Ra from these paints has been given by A. Francis, but it is rather complicated and laborious. B. proposes a simple method which is based on the circumstance that the radioactive ingredient is disposed on the surface of ZnS and can be extd. by comparatively weak agents, which hardly affect the other elements. The scraped-off paint in powder-form is first calcined at low temp. to destroy the gum and then treated with dilute HCl. Ra dissolves, the soln. is concd. by evapn., a few mg. of BaCl₂ and a few vols. of concd. HCl are added and the ppt. of BaCl₂ is allowed to settle for several hrs., after which it is pressed out, washed with concd. HCl and dried to absence of HCl odor. An aq. soln. of this BaCl₂ ppt. which contains most of the Ra, can be used for activation of fresh ZnS. On account of the slight soly. of BaCl₂ in concd. HCl, part of this salt remains in soln. together with some Ra. The amt. of the latter which remains dissolved may reach up to 25%; it can be recovered after pptn. of BaCl₂ by evapg. the filtrate to dryness to remove HCl, dissolving in water and using the soln. for activation of ZnS. By this method B. easily extd. 73.5% of Ra contained in old luminous paints scraped off from dials used in aviation. The new Ra paint thus obtained possessed a high degree of luminosity.

465 Curtiss, L. F. ''Pyrex as a Container for Radium Solution.'' Nature 120, 406(1927).

A pyrex bulb contg. a large amt. of dissolved Ra salts was badly cracked after 2 yrs., the cracks occurred only above the level of the soln.

466 Dawson, A. B. ''A Histological Study of the Response of the Intestinal Mucosa of the Dog to Irradiation, with Special Reference to Giant-Cell Formation.'' J. Exptl. Zool. 46, 467-91(1927).

Intestinal mucosa was exposed to 3 doses of x-rays, measured biologically, (1) 2½ human erythemas (medium wave), (2) 1 human erythema (short wave), and (3) 75% human erythema (short wave); also radium was applied directly to the mucosa. Dose 1 caused complete destruction of mucosa with chronic ulceration, but no leucocytic infiltration. Dose 2 caused loss of villi and destruction of epithelium except in crypt fundi, followed by epithelial proliferation, dedifferentiation, and disappearance of goblet cells. There was little leucocytic infiltration. Conspicuous epithelial giant cells also appeared. Dose 3 caused little tissue injury. Goblet cells were more numerous, leucocytic infiltration was

marked, but limited to mucosa. Radium injury resembled what produced by dose 3 of x-rays, but leucocytic infiltration was more widespread. Giant cells, which appear after exposure to 1 human erythema dose, are of both mononuclear and multinuclear type. Both exhibit phagocytic activity and many show active mitosis. Some mitotic figures are abnormal, and the number of chromosomes is always higher than normal —at least double.

467   Doerner, H. A. and Hoskins, W. M. J. Am. Chem. Soc. 47, 666(1927).
The separation of Ra-Ba chlorides with $BaSO_4$ is described.

468   Dorabialska, A. and Yovanovitch, D. K. "Heat of Radiation of Radiothorium." Roczniki Chem. 7, 23-9(1927).
Comparison made between results for RdTH and those for Ra.

469   Henderson, L. M. and Kracek, F. C. "The Fractional Precipitation of Barium and Radium Chromates." J. Am. Chem. Soc. 49, 738-49(1927).
Fractional pptn. of Ra and Ba chromate from Ra and Ba chloride solns. moderately acidified with HCl or HNO_3 (acidity not over 0.3 N) results in the formation of ppts. whose Ra content per g. of Ba is on the av. 15.5 times that of the resulting solns. This relationship appears to be independent of the fraction of Ba pptd. over the region of Ra/Ba ratio from 10^{-9} to approx. 10^{-2}. In the neighborhood of the upper limit low values were obtained. The results are in agreement with the assumption of solid soln. of $RaCrO_4$ in $BaCrO_4$ over this region of Ra/Ba ratio, deviations from the av. value of the sepn. factor being explainable on the basis of the slow equalization of concn. within the solid particles of the ppt. In neutral solns. low values of the sepn. factor were obtained as a rule. Results with highly acid solns. were irregular, pointing to a decrease in the sepn. factor with increasing acid concn.

470   Jedrzejowski, H. "The Charge of α-Rays Emitted per Second by a Gram of Radium." Compt. rend. 184, 1551-3(1927).
By employing in general the method of Rutherford and Geiger the charge emitted by one g. of Ra per sec. is found to be 33.4 e.s.u., which corresponds to 3.50×10^{10} α particles.

471   Khlopin, V. and Nikitin, B. A. "The Fractional Crystallization of Radioactive Substances, Especially a Search for a Theory of this Process. II. Equilibrium in the System Barium Bromide - Radium Bromide - Hydrogen Bromide and Water at Temperatures from 0° to 25°C." Z. anorg. allgem. Chem. 166, 311-38 (1927).
On addition of HBr to a satd. soln. of $BaBr_2$, the soly. of $BaBr_2$ is diminished to such an extent that a g. equivalent of the HBr ppts. a g. equiv. of the $BaBr_2$. For the system $BaBr_2$, $RaBr_2$, HBr and H_2O, it is shown that the distribution of the radium between the crystals and the liquid phase follows the Berthelot-Nernst distribution formula. The partition constant of Ra between $BaBr_2$ and its satd. water soln. is a function of the acid content of the soln., for a neutral soln. the constant is 52.8. The whole course of the concen-

tration of the Ra through fractional crystallization in HBr soln. follows the formula $XS_1/m = K(1-X)S_0/q$, where X is the quantity of Ra in the crystals, 1-X the quantity of Ra remaining in soln., S_1 and S_0 the corresponding vols., m the weight of the solid phase, q the weight of the resulting soln., K at 25° is 60.24. It is shown that the employment of the radioelements as indicators in experimental studies of dilute solid solns. can be of great value.

472   Meyer, S. and von Schweidler, E. Radioaktivitat. 2ed. Leipzig Teubner. 1927.

473   Sale, J. W. "Report on Radioactivity in Drugs and Water." J. Assoc. Official Agr. Chemists 10, 362-4 (1927).
Description of qual. method for liquids and quant. method for solids, semi-solids, and liquids when Ra must be determined. The methods are those of the Beverage Lab., Bureau of Chem., Washington.

474   Sartory, A. R., Sartory,R., and Meyer, J. "Action of Radium on the Morphological and Biological Constitution of the Adult Vegetable Cell." Bull. sci. pharmacol. 34, 553-64(1927).

1928

475   Bashilov, I. Y. "Extraction of Radium and Mesothorium from Radioactive Chlorides in the Cold." Z. angew. Chem. 41, 57-9(1928).
A description of a method already patented, for the sepn. of Ra or mesothorium chloride from $BaCl_2$ without evaporation. The mixed chlorides are dissolved in water, and a quantity of strong $CaCl_2$ soln. is added sufficient to ppt. at most ⅓ of the $BaCl_2$ present, which then contains about twice as much active chloride as the original mixt. By repeated fractional pptn. a product rich in Ra or MsTh is obtained, together with a soln. of Ba and Ca chlorides, which are recovered by evapn. and crystn. The process is suitable for working up chloride mixts. contg. as little as 0.1 part per million of radioactive chloride. Al and ferric chlorides may also be used as pptg. agents, but as they are susceptible to hydrolysis $CaCl_2$ is preferred.

476   Bashilov, I. Y. Method for Separation of Barium Chloride from Radium Chloride. Russian Pat. 5046 (1928).
Concd. solns. of $CaCl_2$ or other chloride salts are added to the repeatedly recrystd. Ba and Ra chlorides in soln., which do not form compds. sol. in the soln. of Ba and Ra salts.

477   Bothe, W. "The Radium Standard Solution." Z. Physik 46, 896-9(1928).
Standard Ra solns. were tested with an instrument to measure Rn and results obtained are in good agreement with expected values. Solns. kept for nearly 7 years showed the same results as fresh solns.

478   Braddick, H. J. J. and Cave, H. M. "Rate of Emission of α-Particles from Radium." Proc. Roy. Soc. (London) 121, 367-80(1928).

1928

The paper includes an historical and critical account of previous determinations. The authors measure the total charge carried by the α-particles (using a modified Rutherford and Geiger apparatus), and obtain the number of particles by assuming Millikan's value for the electronic charge. Their final corrected result is $(3.68 \pm 0.04) \times 10^{10}$ α-particles/g. Ra/sec., which is in good agreement with the value which can be calculated from the heating effect of the α-particles. It is concluded that there is no evidence of any unrecognized heat-producing mechanism in radioactive disintegrations.

479   Dorabialska, A. "The Heat of the β- and γ-Radiation of Radium." Bull. intern. acad. polon. sci. Classe sci. math. nat. A 459-70(1928).

The heat effect of the β- and γ-radiation of Ra is detn. by means of an adiabatic microcalorimeter constructed by Swientoslawski and the author. RaBr$_2$ equiv. to about 4.45 mg. Ra is used throughout. The heat is absorbed in Cu, Ag, Pb and Wood alloy calorimeters whose absorbing masses were 17.72, 27.72, 32.13 and 37.85 g./cm.^{2}, resp.; the optimum heat capacity of the system was 1-4 cal. with temp. variations from 0.6 to 0.15°. The results found were; $Q_1 = 0.724$, $Q_2 = 0.660$ and $Q_3 = 0.687$ cal./hr., where $Q_1 = q\alpha + q\beta + q\gamma$, $Q_2 = q\alpha + \frac{1}{2}q\beta + \frac{1}{2}q\gamma$ and $Q_3 = q\alpha + q\beta + \frac{1}{2}q\gamma$. Where $q\alpha$, $q\beta$, and $q\gamma$ are the heat values of α-, β-, and γ-radiation respectively. Calcd. for 1 g. Ra the heat effects are 123, 120 and 16.6 cal./hr. for α-, β-, and γ-radiation respectively. Thus, the heat effect of the β-radiation is only 9.1%, and that of the γ-radiation only 12.4% of that of the α-radiation. These values, too low in regard to the theoretical ones, are due to the inclusions of RaD and RaE in the analyzed salt.

480   Gmelin, L. Gmelins Handbuch der anorganischen Chemie. System 31. Radium und Isotope. 8th ed. Berlin, Verlag Chemie. 1928. 80p.

Extensive, organized review with many literature references interspersed in text. Also covers mesothorium 1 (Ra^{228}), ThX (Ra^{224}), and AcX (Ra^{223}).

481   Goldbloom, A. A. "Influence of Oral and Intravenous Administration of Radium Bromide on the Urinary C:N Quotient." Biochem. Z. 197, 14-49(1928).

Daily oral administration or a single intravenous injection of radium bromide raises the C:N quotient, due to decreased N elimination.

482   Hahn, O. and Donat, K. "Is there a Stable Radium Isotope in Barium Minerals?" Z. physik. Chem., Abt. A 139, 143-50(1928).

In view of the fact that Ra has an even at. no. and of the frequent occurrence of the alk. earths on the one hand and of U and Th on the other, expts. were performed to det. whether or not there existed in Ba minerals a stable Ra isotope independent of the radioactive isotopes which appear as disintegration products of U and Th. 220 kg. of BaBr$_2$ was concd. so that the concn. of the hypothetical Ra would be about 500,000 times its original concn. and the concentrate examd. for Ra spectroscopically. No Ra line was obtained. There was a conc. of radioactive Ra, as detd. by the electroscope but this did not reach a spectroscopically determinable amt. There is, therefore, no evidence for the existence of a stable

1928

Ra isotope in Ba minerals in an amt. greater than 2×10^{-10} g./g. Ba.

483   Jedrzejowski, Henri. "The Charge of α-Rays Emitted per Second by a Gram of Radium." Ann. Phys. (10), 9, 128-85(1928).

484   Khlopin, V. and Polesitzkii, A. "Fractional Crystallization of Radioactive Substances. III. The Distribution of Radium between Solid Crystalline BaCl$_2$-2H$_2$O and its Saturated Aqueous Solution at t = 0° and t = 35°." Z. anorg. allgem. Chem. 172, 310-20 (1928).

The extremely small quantities of Ra have no practical influence on the 2 phases so that the present case is not analogous with ternary systems of 2 electrolytes which form mixed crystals and water. Henderson and Kracek in their fractional pptn. of Ba-Ra chromate concluded that the distribution of Ra is analogous to the distribution of a substance between 2 non-miscible solns. The partition factor is D = kc/d, where c is the amount in g. of Ba salt per cc. of the satd. soln. and d = sp. gr. of the solid phase. Detns. of D differ with different investigators, though these deviations were probably due to variations in temp. and acid concn. The distribution of Ra between solid BaCl$_2$ and the neutral satd. aq. soln. strictly obeys the Berthelot-Nernst distribution law. The distribution ratio, K, remains strictly const. at const. temp. and const. compn. of the liquid phase as well as under large differences in the relative amts. of both solvents. Greatly increasing the concn. of the Ra salt (2×10^3 times) does not affect k, for k depends on temp. and the temp. coeff. for this system, between 0° and 35°, is $-0.516/$°C., and from 35° to 57.5° it is $-0.275/$°C. Fractional crystn. of Ra chloride and bromide improves with fall in temp.

485   Lind, S. C. "Pyrex Glass as a Radium Container." Science 68, 643-4(1928).

Results of Curtiss are confirmed. L. placed in a Pyrex system 265 mg. of Ra (RaCl$_2$ soln.) for collection of Rn. Both longitudinal and transverse cracks developed in 1 year in the upper half of the 250-cc. flask. The flask was half full of RaCl$_2$ soln. Conclusion: The cracks were due to the relief of preexisting strains, by expanding under α-radiation. Scaling accompanied by interference colors is indicated. Contraction is possibly caused by α-particle bombardment. Glass of high silica content resembles fused silica in becoming cracked by α-radiation.

486   Longchambon, L. Radium. French Pat. 679,086 (1928).

Ra in soln. is recovered in a concd. form by absorption with natural or artificial zeolites or permutites.

487   Meyer, S. "Relation between the Atomic Weights of Uranium, Radium, RaG and Helium." Sitzber math.-naturw. Klasse Akad. Wiss. Wien 137, 2a, 599-606(1928).

Makes use of Aston's latest determination of the atomic weight of helium, which, for the neutral atom, gives 4.0021$_6$, and Hönigschmid and Schilz's value for uranium, 238.14. Calculates the atomic weights of radium and of radium lead, RaG, taking into account the loss of mass due to the ejection

1928

of α and β particles, and that due to emission of energy. When the facts that 'uranium' is really a complex of UI with from 3 to 4% of AcU, and that radium lead is a complex of RaG + AcD in about the same proportion are considered, the calculated and observed values for RaG are almost identical, but the value calculated for radium is almost 0.1 higher than the experimental value of Hönigschmid. The difficulties in the way of obtaining a correct value for the atomic weight of radium are pointed out.

488   Walter, Z. T. and Schlundt, H. "Partition Coefficient in the Fractional Crystallization of Radium-Barium Bromide Solutions." J. Am. Chem. Soc. 50, 3266-70(1928).

The Ra-Ba bromide system can be made more than twice as efficient as the Ra-Ba chloride system. The crystals are sepd. from the mother liquor by centrifuging. The av. value for the partition coeff. in the Schlundt equation is 6.66 and in the Doerner-Hoskins equation 5.6.

489   Watson, S. W. and Henderson, M. C. "Heating Effects of Thorium and Radium Products." Proc. Roy. Soc. (London) A118, 318-34(1928).

The heat evolution of 5 combinations was measured by a resistance thermometer method. Agreement within 2% of the Hess and Lawson rate of emission of α particles from Ra $(3.72 \times 10^{10}$ per g. per sec.) was obtained.

490   Yamasaki, I. "Information on Radium Hemolysis." Strahlentherapie 29, 363-6(1928).

Radium hemolysis takes place both in air and in an atmosphere of N, more rapidly in N. Both β rays and γ rays are able to induce it.

491   Yovanovitch, D. K. "γ-Radiation and Evolution of Heat from Radium and Mesothorium." J. phys. radium (6) 9, 297-306(1928).

A calorimetric method for the evaluation of the amount of Ms-Th contained in Ra salts is offered. The method is based on measuring the heat given off in the formation of Rd-Th. A microcalorimeter is used.

492   Ziegert, H. "Accurate Measurement of the Number of Ions Produced by a Single α-Particle, and Proof of the Existence of New Activities." Z. Physik 46, 668-715(1928).

The following values were obtained for k, the no. of ions produced by each α-particle in air at 0° and 760 mm.: U I, 1.16×10^5; U II, 1.29×10^5; Ra, 1.36×10^5. The no. of α-particles per g. of Ra per second is $Z = 3.71 \times 10^{10}$. Metals for which radioactivity has not been observed were tested. No characteristic activity was found for Cu or Zn, but the metals Al and old Pb were shown to contain an amt. of Ra of the order of magnitude 10^{-14} g./g. of metal. Residues and ppts. from solns. of Zn showed certainly the existence of new activities, the nos. of ions produced by each ray being 0.42×10^5, 0.69×10^5 and 1.01×10^5.

1929

493   Frilley, M. "Spectrography of the γ-Rays of the Radium Family by Means of Crystalline Diffraction." Ann. Phys. (10), 11, 483-567(1929).

1929

Contains a fully illustrated account of the method employed in the measurements previously recorded. Emphasizes the difficulty of determining the intensity of the different γ-rays concerned, either by the author's method or by those employed by other experimenters. Considers the origin of certain of the γ-rays in nuclear levels; the results so far obtained are not sufficient to resolve the numerous difficulties which exist in the theory of the nuclear structure and of radio-activity. The author is investigating an electrometric spectrographic method, which seems capable of getting over the difficulties due to the low intensities of the sources employed.

494   Glaser, O. and Mautz, F. R. "The Significance of the r-Unit for the Determination of the Dose of γ Rays of Radium." Strahlentherapie 34, 845-54(1929).

Intensities of various combinations of Ra preparations were determined in r-units with the condenser dosimeter and small ionization chambers ($\frac{1}{35}$ cc.) for different filters, distances, etc. The results are collected in a number of curves and tables. The skin unit dose for γ rays was determined as 2000 r.

495   Heyrovsky, J. and Berezick, S. "The Deposition of Radium and Other Alkaline Earth Metals at the Dropping Mercury Cathode." Chem. News 138, 180-4, 195-7(1929).

The "deposition potentials" from normal ionic concns. are estd. for Ra -1.718, Ba -1.761, Sr -1.964, Mg -1.996, and Ca -2.047 v. from the normal calomel zero. From the magnitude of the diffusion current, Ra may be followed quant. in mixts. with Ba from the ratio Ra:Ba = 1:10 to 25:1, in concns. 10^{-4}M, 2 cc. being necessary for the detn. Traces down to 10^{-5} g. equiv. per l. of Ra or Ba are detd. in the same way in any amt. of alkalies or alk. earths; Sr is detd. only in mixts. with alk. earths or Li. The applicability of the polarographic method for the detn. of solubilities of sparingly sol. salts is tested and found comparable to the conduction method. The deposition of Mg and Be even from very small concns. is accompanied by an evolution of H_2. By means of this action small amts. of Mg may be roughly estd. "Adsorption currents" with well-defined max. are best shown on current-voltage curves of solns. of the heavy alk. earths. Examples are given of polarographic titrations of Ba, Sr, and Ca ions.

496   Heyrovsky, J. and Berezicky, S. "The Deposition of Radium and Other Alkaline Earth Metals at the Dropping Mercury Cathode." Collection Czechoslov. Chem. Comm. 1, 19-46(1929).

This article contains the same information as the previous reference.

497   Heyrovsky, J. and Berezicky, S. "The Deposition of Radium and Other Alkaline Earth Metals at the Dropping Mercury Cathode." Rozpravy II. tr. Ces. Akad. 38, No. 8(1929).

This article contains the same information as the previous reference.

498   Khlopin, V., Polesitzkii, A., and Tolmachev, P. I. "The Distribution of Radioactive Substances between Solid Crystalline and Liquid Phases. IV.

1929

The Distribution of Radium between Solid Crystal-
line Barium Nitrate and Its Saturated Aqueous Solu-
tion at 0° at 25°." Z. physik. Chem., A 145, 57-66
(1929).

At const. temp the distribution ratio (expressed as K =
C_S/C_L, where C_S and C_L are the concns. of Ra isomorphous
in the cryst. and liquid phases, resp.), is const. over a 3-
to 4-fold change in Ra concn. Equal values of K are found
by 2 methods; (a) by crystn. of $Ba(NO_3)_2$ from active soln.
at const. temp. and (b) by prolonged agitation of inactive
$Ba(NO_3)_2$ crystals with active satd. soln. of $Ba(NO_3)_2$. It is
concluded that a true state of equil. exists and that the
Berthelot-Nernst distribution law applies within the limits
of exptl. error. At 0°, K = 154 ± 1.25% and D = 2.31; at 25°,
K = 46 ± 1.5% and D = 149. D = KC/d defines the partition
factor, where C is the concn. of $Ba(NO_3)_2$ in g. per cc. of
soln. and d is the sp. gr. of $Ba(NO_3)_2$ crystals. Fractional
crystn. by means of Ba-Ra nitrate is possible but not as
favorable as with bromides and chlorides previously studied.

499   Khlopin, V. and Polesitzkii, A. "The Distribution
         of Radioactive Substances between Solid Crystalline
         and Liquid Phases. V. The Distribution of Radium
         between Mixed Crystals of Barium and Lead Nitrate
         of Varied Composition and Their Saturated Aqueous
         Solutions at 25°." Z. physik. Chem., A, 145, 67-78
         (1929).

The distribution ratio of Ra between cryst. and liquid
phase is a function of the compn. of the system and lies be-
tween the values K = 46 for pure $Ba(NO_3)_2$ and K = 18 for
pure $Pb(NO_3)_2$ in equil. with their resp. satd. aq. solns. at
25°. With fixed proportions of Ba and Pb in the 2 phases the
distribution of Ra obeys the Berthelot-Nernst distribution
law within the limits of exptl. error. Analyses of the mixed
crystals and their equil. solns. show interdependence in
compn. of the phases, and fair agreement with the earlier
results of Glasstone and Riggs.

500   Neufeldt, H. "Estimation of Radium Preparations
         with the Electron Counter by Means of the γ-Ray
         Method." Physik. Z. 30, 494-5(1929).

By means of the Geiger and Müller electron counter, 10^{-6}
mg. Ra was estd. with an accuracy of 10%, against 2×10^{-3}
mg. by the most sensitive method heretofore used. Six hrs.
was required for the estn., the record being made automati-
cally.

501   Schlundt, H., Barker, H. H., and Flinn, F. B. "The
         Detection and Estimation of Mesothorium in Living
         Persons." Am. J. Roentgenol. Radium Therapy 21,
         345-54(1929).

Seven persons who had worked in Ra refineries or luminous-
material plants and who might have ingested radioactive ma-
terial were studied. Electroscope measurements of the γ-ray
activity of the subject were made with a Wulf-Hess quartz-
fiber instrument. Emanation measurements of the expired
air were made with a Lind instrument with a large ionization
chamber. Methods for estg. the total radioactive material
present, and for discriminating between Ra and MsTh are
given.

502   Sokolov, V. A. "Determination of Radium Content
         Using the γ-Rays." Z. Physik 54, 385-98(1929).

1929

The γ-ray method for the detn. of Ra is as accurate and
more convenient than the α-ray or emanation methods. A
γ-ray electroscope with a sensitivity of 2×10^{-10} g. Ra per
g. of substance is described.

503   Steadman, L. T. "Wave-Length Measurement of
         γ-Rays from Radium and Its Products." Phys. Rev. (2),
         33, 120(1929).

γ-Rays from Ra were diffracted by a calcite crystal. Re-
sults agree well with those of previous workers. Wave lengths
in X. U. were: 34.1, 25.9, 27.9, 23.9, 19.7, 16.2, 12.3, 10.6,
5.3; the lines 68.1, 38.9, 21.1, and 17.6 were probably of the
second order. Other lines of intermediate and shorter wave
length were observed.

504   Vernadskii, V. K. "The Concentration of Radium
         by Living Organisms." Compt. rend. acad. sci.
         URSS. 33-4(1929).

505   Ward, F. A. B., Wynn-Williams, C. E., and Cave,
         H. M. "Rate of Emission of α-Particles from Ra-
         dium." Proc. Roy. Soc. (London) A125, 713-30
         (1929).

The no. of particles has been counted directly by means
of a Greinacher counter, which consists of an ionization
chamber, a valve amplifier and a recording instrument. The
no. of particles emitted from a g. of Ra was found to be
3.66×10^{10}/sec.

1930

506   Erbacher, O. "Solubility of Radium Salts." Ber.
         63B, 141-56(1930).

Known vols. of Ra salt solns. of known purity were evapd.
to dryness and the activity was compared with a standard
sample for detn. of soly. Soly. in 100 g. of water was: $RaBr_2$
70.6 g., $RaCl_2$ 24.5, $Ra(NO_3)_2$ 13.9. Comparison with values
for similar alk. earth salts shows no simple relationship
between soly. and degree of purification by fractional crystn.
The soly. difference is less for the bromides than for the
chlorides but the degree of purification is greater. Crystn.
of $Ra(NO_3)_2$ showed little improvement in purity, contrary
to previous work, although $Ra(NO_3)_2$ is more sol. than
$Ba(NO_3)_2$.

507   Erbacher, O. and Kading, H. "The Reaction Mech-
         anism in the Precipitation of Highly Emanating
         Radium Preparations." Z. physik. Chem., Abt. A,
         149, 439-48(1930).

Ppts. of $RaCO_3$, $RaSO_4$ and $RaCrO_4$ were prepd. in 2 ways
with $Fe(OH)_3$ and $Al(OH)_3$ gels. The first series was pptd.
by adding $FeCl_3$ and $RaCl_2$-$BaCl_2$ solns. to NH_4OH and the
anion in excess. The ppt. was dried in moist air. In the
other series the Ra soln. was added to the gel and the anion
soln. then added. The emanating power of the ppt. was tested
after 25-47 days on the product dried in moist air and dried
with alc. Directions are given for prepg. a ppt. of the highest
emanating power, which does not lose its strength upon stand-
ing.

508   Flint, H. T. and Grimmett, L. G. "Measurement
         of the Distribution of Gamma Rays around a Four-

1930

Gram Mass of Radium." Brit. Med. J. 2, 98-9 (1930).

509   Fulton, R. G. "The Quantitative Determination of Radium by the Emanation Method." J. Assoc. Official Agr. Chem. 13, 497-503(1930).

The method proposed by Sale for examg. radioactive material was applied to a water sample, a sol. salt sample and a refractory substance, and was found to be reliable. Several modifications in technique resulting in simplicity and convenience, without loss of accuracy, are suggested. The method was checked by the Schlundt and Moore method (J. Phys. Chem. 9, 320(1905)) and by Barker's bisulfate fusion method both of which are in general use at the Univ. of Missouri in making Ra assays.

510   Glaser, O. and Mautz, F. R. "The Measurement of the Intensity of the γ-Rays of Radium in r Units." Radiology 15, 93-100(1930).

With certain precautions and under certain conditions the r unit can be satisfactorily employed to measure the intensity of the γ-rays of Ra. Various types of ionization chambers are described and illustrated. With the γ-rays of Ra, 2000 r units will produce a reaction on the human skin which is usually designated as a skin unit dose.

511   Khlopin, V. G. and Ratner, A. P. "Distribution of a Dissolved Substance between the Crystalline and Liquid Phases. VI. Distribution of Radium between Crystalline Lead Nitrate and Its Saturated Solutions at 0° and 25°." Compt. rend. acad. sci. U.R.S.S. A. No. 27, 723-30(1930).

The distribution of Ra between cryst. $Pb(NO_3)_2$ and its satd. aq. soln. follows strictly the Berthelot-Nernst distribution law. The distribution const. K, is 36.3 and 18.2 at 0° and 25°, resp. Addn. to the satd. soln. of $Pb(NO_3)_2$ of foreign compds., not isomorphous with it, has a pronounced effect on the distribution const. of Ra. If this addn. diminishes the active concn. of Pb^{++}, K increases, and vice versa. The addn. of foreign compds. which form complex ions or little dissocd. mols. with Pb but not with Ra, raises the coeff. of enrichment of Ra in the crystals of $Pb(NO_3)_2$. This fact presents a practical possibility for sepn.

512   Riehl, N. and Kading, H. "The Distribution Law for Fractional Crystallization of Radium Salts." Z. physik. Chem., Abt. A 149, 180-94(1930).

Two formulas have been proposed for fractional crystn. of Ra salts, one by Doerner and Hoskins (ln a/y = λln b/n, where a = amt. Ra in soln. before pptn., y = amt. Ra in soln. after pptn., λ = a const., b = amt. Ba in soln. before pptn. and n = amt. Ba in soln. after pptn.) and one by Khlopin

$$\frac{\text{amt. Ra in crystals}}{\text{amt. Ba in crystals}} = D \times \frac{\text{amt. Ra remaining in soln.}}{\text{amt. Ba remaining in soln.}}\text{,}$$

where D is a const.

If the process is carried out slowly so that equil. exists between the crystals and the soln., the equation of D. and H. is valid. If the crystn. is done rapidly from a super-satd. soln. no true equil. exists between the soln. and the crystals then the K. equation holds.

1931

513   Belt, T. H. "On a Fatal Pulmonary Fibrosis from Industrial Radium Injury." Frankfurt. Z. Path. 42, 170-87(1931).

This article reports the case of a chemist who worked for about 4 yrs. in a chemical factory filling radium needles. He was constantly handling Ra salts and mesothorium in small quantities. Though his hands were protected as much as possible he suffered occasional Ra burns on his fingers. After 2 yrs. he gradually developed shortness of breath which increased slowly but steadily and about a month before death confined him to bed. At this time X-ray plates of the chest showed a diffuse, finely nodular "snow flurry" shadow throughout both lungs. Both the patient and the clinicians believed the condition was due to injury to the lungs as the result of inhaling the volatile fractions of radioactive salts. At autopsy, the main finding was a diffuse interstitial fibrosis of both lungs, which had greatly reduced the vital capacity. Histologically this fibrosis was without specific qualities. The condition resembled "lymphangitis reticularis" of the lung described by von Hansemann (Virchow's Arch. Path. Anat. u. Physiol. 220, 311-22(1915)). The patient had no antecedent disease of the lung to which the fibrosis might be related. Portions of lung tissue were tested for radioactive substances, with negative results. The possible etiological relationship of Ra to the lung injury is not proven but is suggested by the absence of other demonstrable etiological factors. There are no similar cases on record.

514   Dettelmaier, R. "The Determination of the Number of Alpha Particles Emitted per Second per Gram of Radium." Sitzber. math.-naturw. Klasse Akad. Wiss. Wien, Abt. IIa 140, 347-51(1931).

Measurements made both by the ionization and charge transport methods were obtained on prepns. of Po and the results calcd. over to Ra by means of the known equil. between Po and Ra. The no. of α-particles emitted by 1 g. Ra/sec. has thus been detd. to be 3.7×10^{10}.

515   Guerillot, J. "Influence of Radium on the Nitrification of Ammonium Sulfate." Bull. soc. chim. biol. 13, 367-8(1931).

516   Khlopin, V., Polesitzkii, A., Ratner, A. P., and Tolmachev, P. I. "The Relation between Solid Solutions and Mixed Crystals and the Conditions under Which a True Equilibrium between Them can be Realized Experimentally." Ber. 64B, 2653-66(1931).

The distribution of a dissolved substance between two immiscible liquid phases is completely analogous to the distribution of a solute in a system of one solid cryst., and one liquid phase. This was shown by study of the distribution of $RaBr_2.2H_2O$ between solid $BaBr_2.2H_2O$ and its satd. soln. at 35° and at the b.p., of $RaCl_2.2H_2O$ between solid $BaCl_2.2H_2O$ and its satd. soln. at 35° and at the b.p., and of $Ra(NO_3)_2$ between solid $Ba(NO_3)_2$ and its satd. soln. at the b.p.

517   Mumbrauer, R. "The Regularity of the Precipitation of Substances in Small Quantities in the Formation of Mixed Crystals." Z. physik. Chem., Abt. A, 156, 113-34(1931).

The systems Ba-Ra-Br, Ba-Ra-Cl, Ba-Ra-NO_3 and Ba-Pb-NO_3 were studied in (1) slow crystn. from supersatd.

1931

solns. to complete equil., the degree of supersatn. varying;
(2) interrupted slow crystn. from supersatd. solns. of the
same initial concn., crystals and soln. being examd. after
varying time intervals; (3) rapid crystn. from solns. of
varying degrees of supersatn., the crystals being filtered
from the mother liquor immediately. In (1) the Nernst-
Berthelot equation is valid, the const. D of that equation
being independent of the degree of supersatn. In (2) the
crystals formed are homogeneous throughout the process,
the ratio percentage of Ra pptd./percentage of Ba pptd.
being const. In (3) the value of λ in the equation ln (Ba in
soln. before pptn./Ba in soln. after pptn.) = λ ln (Ra in soln.
before pptn./Ra in soln. after pptn.) was found to be const.,
the degree of supersatn. not influencing its value. However,
if these crystals obtained as in (3) were allowed to stand
several hrs. in contact with their mother liquor, a recrystn.
took place and the ultimate product corresponded to the
crystals obtained in (1). Exptl. methods are given and the
results well presented in graphs and tables.

518   Schlundt, H. and Failla, G. "The Detection and
        Estimation of Radium in Living Persons. III. The
        Normal Elimination of Radium." Am. J. Roentgenol.
        Radium Therapy 26, 265-71(1931).
   The subject for these expts. were 2 girls who had con-
tracted Ra poisoning during employment as dial painters in
1917-1919, and who carry at the present time approx. 24
and 36 microgram of Ra, resp. The total daily elimination
was found to be 0.005 and 0.0026%, resp. This difference is
explained by a marked difference in the rate of metabolism
in the 2 subjects.

519   Starik, I. E. and Gurevich, A. M. "Adsorption of
        Radium by Glass." Compt. rend. acad. sci. (U.R.S.S.)
        A. No. 12, 331-5(1931).
   Radioactivity of neutral and acid solns. in glass tubes con-
taining 3.6×10^{-8} g. Ra in 5 cc. of soln. was measured with
a Schmidt app. The initial activity of the neutral soln. was
211 divisions/min.; of the acid soln. (N/6 HCl) 297.2 div./min.
After 20 days the radioactivity became practically constant,
having decreased in the acid soln. to 210 and in the neutral
to 145. Addn. in the beginning to the neutral solution of HCl
to a concentration of N/6 raised the activity to 295.4. Addn.
of HCl after the neutral soln. reached its min. activity raised
the activity to 210. Ra is thought to be absorbed and adsorbed
by glass. Absorption is independent of the acidity of the soln.,
but the adsorbed layer is washed off by acid.

1932

520   Albertson, W. "Classification of Certain Lines of
        Radium." Phys. Rev. (2), 39, 385-6(1932).
   The Ra spark lines of 6446.1, 5823.7, 2836.5, 2813.7 and
2708.9 Å may be accounted for by assuming a set of doublet
levels at 73,820; 72,162 cm^{-1} and at 36,917; 36,632 cm^{-1}.
This is discussed.

521   Behounek, F. and Koblic, O. "The Inhomogeneity
        of Highly Active Radium Barium Chloride." Physik.
        Z. 33, 366-8(1932).
   Several prepns. of Ra-Ba chloride were divided into many
small samples. Each of these was weighed and its Ra content

1932

detd. No significant differences were found. After 18 months
one of the samples was again divided and tested. Variations
in Ra content from 56.54 to 70.75% were found. These dif-
ferences are ascribed to a concn. of RaCl$_2$ in some of the
crystals during their prepn. No evidence was found to sup-
port the view that on standing the prepns. change from the
chloride to the chlorate.

522   Erbacher, O. and Nikitin, B. A., "Solubility of Radium
        Sulfate in Water at 20°." Z. physik. Chem. A158,
        216-30(1932).
   One-hundred cc. of H$_2$O dissolves 1.50×10^{-4} g. The solute
is powerfully adsorbed by filtering materials. RaSO$_4$ slowly
decomposes under the influence of its own radiation, but
this change occurs chiefly on the surface; it is practically
immaterial whether the surrounding medium is air or H$_2$O.

523   Karl, A. "Determination of Radium in Insoluble
        Substances." Bull. Soc. chim. 51, 1023-9(1932).
   The emanation method for detg. Ra by M. Curie and others
is outlined and a greatly simplified procedure is described
in which 1 g. of substance is first treated with H$_2$SO$_4$ and HF
in a Pt vessel and the nonvolatile residue then fused with
10 g. of KHSO$_4$. After the fusion, 2 g. of Li$_2$SO$_4$ and 3 g. of
Na$_2$SO$_4$ are added and the mixt. is fused again. This melt
is cooled in a desiccator over H$_2$SO$_4$. An aliquot part is
taken for the emanation test but instead of bubbling air
through an acid soln., as has been the practice hitherto,
air is bubbled through the melt obtained by heating in an
elec. furnace.

524   Karl, A. "Determination of Radium in the Presence
        of Alkaline Earth Sulfates." Compt. rend. 194, 613-
        14(1932).
   An equimol. mixture of NaCl, KCl and LiCl is used in
place of KHSO$_4$ or NaHSO$_4$ in the fusion method for the detn.
of Ra.

525   Nikitin, B. A. and Erbacher, O. "Validity of Mass Law.
        I. Solubility of Radium Sulfate in Sulfuric Acid and
        Sodium Sulfate Solutions." Z. physik. Chem. A158,
        231-6(1932).
   The activity product of RaSO$_4$ at 20° has approx. the same
value in H$_2$O, 0.0001-0.1N H$_2$SO$_4$ and 0.01-0.1N Na$_2$SO$_4$.

526   Rosenblum, S. "Fine Structure of the Magnetic
        Spectrum of the α-Rays of Radium." Compt. rend. 195,
        195, 317-19(1932).
   The photographs obtained showed a sharp edge on
the high-velocity side and a gradation toward slower
rays. With long exposures (3-12 hrs.) to Ra a line weaker
than the high-velocity edge was observed; it is attributed to a
slower ray. By assuming that the velocity of the α-rays
from RaA is 1.698×10^9 cm. per sec., the following α-ray
velocities were detd.: for Ra, 1.517×10^9, for the secondary
α-rays of Ra, 1.488×10^9, for Rn 1.623×10^9 cm. per sec.
The value for Ra differs by 0.4% from the accepted value.
The difference in energy between the main and secondary
α-rays is 185 kev., agreeing with the value of 189 kev. for
a quantum of γ-radiation. From the intensity of the secondary
line the ratio of the no. of quanta of γ-radiation emitted to
the total no. of atoms decompg. can be calcd.

1932

527   Rosenblum, S. and Chamié, C. "The Fine Struc-
ture of α-Rays from Radiothorium." Compt. rend.
194, 1154-5(1932).

This work represents the 1st. detn. of the velocity of α-rays from RdTh and its derivs. The RdTh and MsTh$_2$ (Ac^{228}) were sepd. from MsTh$_1$ (Ra^{228}) and ThX (Ra^{224}) by double pptn. of BaCl$_2$ in excess HCl.

528   Sabin, F. R., Doan, C. A., and Forkner, C. E. "The
Production of Osteogenic Sarcomata and the Effects
on Lymph Nodes and Bone Marrow of Intravenous
Injections of Radium Chloride and Mesothorium in
Rabbits." J. Exptl. Med. 56, 267-89(1932).

Of 9 rabbits, 5 received radium chloride and 4 mesothorium injections intravenously once a month. The blood cells were counted once a week. The differential counts were made with the supravital technique. One animal died 25 days after 1 injection; a second was killed after 3 injections; the other 7 were killed at intervals of 11-19 mos. after the first injection. Each animal was killed when signs of some damage became evident, such as a fracture or marked weakness. The animals receiving the radium chloride survived the longest and showed fewer signs. Several phenomena were observed: marked changes in the lymphoid tissues eventually registered by a lymphopenia; a slight anemia associated with a destruction of red blood cells and, within the limits of this experiment, with only minimal changes in the bone marrow; atrophy of the thymus; a damage to the liver cells and a reduction in size of this organ; the frequent development of abscesses; 1 spontaneous fracture; and in 2 instances the development of osteogenic sarcomata. The observations suggest that with certain doses of radioactive material, the fundamental damage in the lymphoid tissues is to the stem cell and that the damage is to the chromatin of the nuclei. The erythroid tissues are apparently less susceptible but an original anemia of secondary type from peripheral destruction may eventually be changed to one of primary type through decreased maturation of primitive cells in the marrow. The damage of lymph nodes and bone marrow leads to atrophy of these organs. The cells of the liver and thymus suffer nuclear damage of the same general character as is seen in the lymph nodes, and there is an atrophy of these organs. The storage of the radioactive material in the bones gave rise to osteogenic sarcomata in 2 out of 7 rabbits surviving 11-19 mos.

529   Stahel, E. "The Number of Secondary β-Rays
Emitted by Radium." Compt. rend. 194, 608-10
(1932).

A Geiger counter was used. At a pressure of 60 mm. the average of 5 determinations was 5.0 ± 1.0 secondary β-rays emitted/100 atoms decomposed. At 240 mm. the results were about the same.

530   Stahel, E. and Johner, W. "The γ-Radiation of Ra-
dium." Helv. Phys. Acta 5, 310-11(1932).

The no. of γ-quanta from Ra is about 1.3% as shown by measurements with a MeI ionization chamber. The amt. of secondary β-radiation is 5% and the total γ-emission therefore 6.3%. This also shows that the "internal absorption" of γ-radiation is about 80%.

531   Weissenborn, A. "The Production of High-Percentage
Radium or Mesothorium Preparations." Metallbörse
22, 689-90, 721-2(1932).

1932

Detailed precautions and instructions with crystn. schemes are given for commercially concg. Ra or MsTh content of Ba, Ra or MsTh chloride and bromide. Chloride crystals contg. 0.01 to 0.03 mg. radioactive element per kg. after the tenth crystn. contained 1.2 to 1.6 mg. Ra and after the seventeenth crystn. contained 18 to 26 mg. Ra per kg. When chloride crystals contain 20 mg. Ra per kg. it is profitable to convert to bromide, since then one crystn. will about double Ra content whereas two crystns. of chlorides are required for the same result. Prepns. contg. 22-30 mg. Ra per 100 mg. calcined bromide were obtained.

1933

532   Becker, A. "Radium Solutions." Z. Physik 83,
701-10(1933).

The constancy of the escape of Rn from Ra soln. has been tested over a period of 18 years and found to vary not more than 1%, which corresponds to the exptl. error. Sulfate and carbonate have some influence and may lead to considerable errors.

533   Bishop, E. R. and Dollins, C. B. "Radium Isotopes."
Phys. Rev. (2), 43, 48(1933).

The magneto-optic method shows that Ra has 4 isotopes with probable masses, in order of decreasing abundance, of 226, 228, 230, 232.

534   Evans, R. D. "Radium Poisoning. A Review of
Present Knowledge." Am. J. Pub. Health 23, 1017-
23(1933).

Thirty-two references are included.

535   Haissinsky, M. "Separation of Elements 88 (Ra),
89 (Ac) and 90 (Th) by the Use of Organic Solvents."
Compt. rend. 196, 1788-9(1933).

The use of org. solvents has enabled H. to separate a mixt. of disintegration products of Th and also a mixt. of AcX (Ra^{223}) and radioactinium. Only the first sepn. is published now. A dry mixt. of La nitrate and Ba(NO$_3$)$_2$ contg. MsTh$_1$ (88), MsTh$_2$ (89), RdTh (90), and ThX (89) is treated with abs. EtOH and filtered. The residue contains the Ba, MsTh$_1$, ThX (Ra^{224}) and 5/10% MsTh$_2$ and RdTh and can be freed from the two latter by repeating the EtOH treatment 2-3 times. When Th nitrate and then pyridine are added to the EtOH filtrate a gelatinous ppt. of Th and RdTh is formed and the filtrate contains in a very pure state the La and MsTh$_2$. The active deposit is chiefly in the EtOH-pyridine filtrate and can be removed by adding Pb(NO$_3$)$_2$ and pptg. with H$_2$S. The La and MsTh$_2$ can be sepd. by forming the hydroxide or oxalate.

536   Kolbe, E. A. "Large-Scale Production of Radium
Compounds." Chem.-Ztg. 47, 213-14(1933).

A brief historical account, dealing particularly with the work of Kroupa.

537   Marques, B. E. "The Distribution of Radium in the
Fractional Precipitation of Barium Chloride."
Compt. rend. 196, 1309-11(1933).

A study was made of the fractionation of Ra and Ba by the pptn. of BaCl$_2$ with concd. HCl at 20°. The concns. of Ra and Ba in the solid and liquid phases were detd. The coeff. of

1933

enrichment K_e (= % Ra/% Ba in the ppt.) decreases with increase in the amt. of the ppt. The coeff. is independent of the concn. of the original soln.

538   Marques, B. E. "Fractional Crystallization of Radium-Bearing Barium Chloride." Compt. rend. 197, 1314-15(1933).

The function $\lambda = \log (Ra)_0/(Ra)_x + \log (Ba)_0/(Ba)_x$, in which (Ra) is the concn. of Ra ions in soln. and subscripts 0 and x mean before and after crystn., resp., is cald. In slow crystn. λ is const. but in rapid crystn. λ decreases as the concn. increases.

539   National Research Council (US.) International Critical Tables of Numerical Data, Physics, Chemistry and Technology. NY., McGraw-Hill. 1928-1933.

Ra boiling pt. (vol. 1 p. 102); density (vol. 1 p. 104), emission spectra (vol. 5 p. 311); melting point (vol. 1 p. 104); persistent lines (vol. 5 p. 324); quantum numbers (vol. 5 p. 408), spectral series (vol. 5 p. 403); X-ray emission spectra (vol. 6 p. 42); Zeeman effect (vol. 5 p. 420); $RaCl_2$ diffusion in H_2O (vol. 6 p. 231 and 234); $RaBr_2$ electrical conductivity in Ag (vol. 6 p. 231 and 234); $RaCl_2$ diffusion in H_2O (vol. 5 p. 66); $RaSO_4$ soly. in H_2O (vol. 4 p. 233); and freezing point-soly. in H_2O (vol. 4 p. 353 and vol. 7 p. 344).

540   Nikitin, B. A. and Tolmachev, P. I. "The Validity of the Law of Mass Action. II. Determination of the Solubility of Radium Sulfate in Sodium Sulfate Solutions and in Water." Z. physik. Chem. A167, 260-72 (1933).

The soly. of $RaSO_4$ in water at 20° is 2.1×10^{-4} g. per 100 cc. water. The soly. of $RaSO_4$ solns. contg. SO_4^{--} ions accurately follows the law of mass action if the exptl. procedure excluded errors due to absorption. The soly. product remains const. at 4.25×10^{-11} over a wide range of ionic concns.

541   Piccard, A. and Meylan, L. "A Zero Method for the Determination of Radium by γ-Radiation." J. phys. radium (7), 4, 715-18(1933).

By using 2 identical ionization chambers 20 cm. in diam. contg. CO_2 under 10 atms. pressure connected to the same electrode and leaf system, an app. following the principles of Rutherford and Chadwick's γ-ray method for the detn. of Ra is obtained which enables more accurate measurements to be made more quickly. The unknown sample is moved until its effect exactly balances the known and the scale reading observed. The refinements introduced make the method suitable for rapid measurements of av. precision.

542   "Radium and Uranium from Great Bear Lake Ore." Can. Chem. Met. 17, 251-3(1933).

Ra and U have recently been extd. from the ores of the Great Bear Lake region. The ore is crushed, roasted, pulverized to 35-mesh, boiled with HCl, filtered on a stoneware filter, and washed with water. The residue contg. the Ra is treated with satd. NaCl soln. to dissolve the $PbCl_2$. A certain amt. of Ba must be present before boiling with Na_2CO_3 to convert both Ba and Ra to carbonate. Filtering leaves the carbonates along with the SiO_2. The carbonates are dissolved in HCl and Ba and Ra repptd. as sulfates. The sulfate mixt. contains 2-10 mg. Ra/kg. The sulfates are again converted to carbonate, washed, dissolved in HBr

1933

and the soln. is purified by the use of $Ba(OH)_2$. Ra and Ba bromides are sepd. by fractional crystn. U is recovered as Na salt, recovery beginning at the point where the HCl leach gives the U in soln.

543   Rasmussen, E. "The Arc Spectrum of Radium." Z. Physik 87, 607-15(1933).

The arc spectrum of Ra is studied in the region 3000 - 10,000 Å. The ionization potential is 5.176 v.

544   Ratner, A. P. "Theory of the Distribution of Electrolytes between a Solid Crystalline and a Liquid Phase." J. Chem. Phys. 1, 789-94(1933).

Equations are deduced from the general theory of thermodynamic potential and the activity theory of strong electrolytes, giving the effect of the compn. of the liquid phase on the distribution ratio and the dependence of the partition const. on the properties of the pure components. The relative importance of the various factors in these equations is discussed. The equations agree with exptl. data for the pairs $Pb(NO_3)_2$-$Ra(NO_3)_2$ at 25°, $BaBr_2$-$RaBR_2$ at 0° and $Ba(NO_3)_2$-$Ra(NO_3)_2$.

545   Rusakov, V. P. "Radium and Thorium Contents of Phosphorites." Compt. rend. acad. sci. (U.R.S.S.)A. No. 3, 25-33(1933).

The Ra and Th contents of phosphorites were detd. by the emanation (soln.) method.

546   Thomas, H. E. and Bruner, F. H. "Chronic Radium Poisoning in Rats." Am. J. Roentgenol. Radium Therapy 29, 641-63(1933).

A typical secondary anemia occurred upon injection of $RaCl_2$, red blood cells falling as low as 1/5 N. The injected rats gained weight more slowly than controls, and before death lost weight rapidly. There was a decrease in calcification in the central portions of all bones, a concn. of Ca salts in the parts of the bones nearest the joints, abscesses in the soft tissue around the mandibles, hyperplastic and aplastic bone marrow, great destruction of lymphocytes in spleen and lymph nodes, and degeneration of certain glands. Analysis of the postmortem specimens showed that over 99% of the retained Ra was found in the bone ash, there being little difference in concn. in different bones. The organs dealing with Ca metabolism had a higher concn. of Ra than other soft tissues. Approx. 50-65% of the Ra injected was eliminated within a week; after that elimination went on at an approx. rate of 0.6% per week. At death the av. retention was about 25%.

547   Weil, K. and Peters, K.   Concentrating Radioactive Material by Treating Radium-Barium Carbonates. U.S. 1,927,726(1933).

A Ra-Ba carbonate mixt. is heated to 400-800° in a high vacuum to effect selective dissocn. of the $BaCO_3$ and the BaO formed is leached out with water.

1934

548   Gerlach, W. and Riedl, E. "Spectroanalytical Studies. XIII. The Spectroscopic Test of Purity of the New Primary Radium Standard." Z. anorg. u. allgem. Chem. 221, 103-8(1934).

1934

The Ba content was detd. by using the salt in an arc between highly purified Ba-free Cu electrodes. The intensities of the Ba lines from the salt were obtained by comparison with lines in the Cr I spectrum. The Ra salt contained 0.002-0.003 atom % Ba.

549   Hönigschmid, O. and Sachtleben, R. "A Revision of the Atomic Weight of Radium." Z. anorg. u. allgem. Chem. 221, 65-82(1934).
Complete details are given of a new detn. of the ratio $RaBr_2/RaCl_2$, leading to a revised atomic wt. of 226.05. The Ra salt contained 0.002-0.003 at. % Ba.

550   Johner, W. and Stahel, E. "Temporal Sequence of α- and γ-Radiation of Radium." Helv. Phys. Acta 7, 638-9(1934).
It is proposed to det. the relative order of α- and γ-ray emission from Ra by examn. of the absorption of the K-lines, excited by inner absorption of the γ-radiation, in Tl, Au and Hg filters. Absorption corresponding with the Rn spectrum would indicate emission of γ-radiation after loss of the α-particle. Preliminary results indicate emission of Ra K-radiation.

551   Lepape, A. and Trannoy, R. "Influence of Radium on Vegetation." Ann. agron. (N.S.) 4, 319-54(1934). (1934).
The amounts of radium detectable in carrots, barley, turnips, nettles, wheat, poppies, corn, and kidney beans were investigated. The quantity of radium measurable in fresh or dry crops varied with the value in the soil, as did also the amt. detectable in the ashes. The least amt. of radium was detectable in the fruits of the plant; the most was found in the leaves. No apparent effect was obtained from radium administered to the soil in small or medium-large doses; after strong doses, harmful effects were evident. Plants extract from the soil a fraction of the radium contained in it. For soils naturally rich in radio-active elements, the authors suggest investigations to determine if the quantities of radium carried into the living cells by vegetables may not produce harmful effects in time.

552   Lepape, A. and Trannoy, R. "Fixation by Plants of Radium Available in the Soil." Compt. rend. 199, 803-5(1934).
Ra naturally present or added to soils was taken up by agricultural crops to the extent of 0.0001-0.001 of the total per year. Crops grown on soils rich in Ra and used for food introduce appreciable quantities of Ra into the animal organism.

553   Loeb, L. B. "Nature, Effects and Menace of Radium Poisoning in Water." Water Works Eng. 87, 217-18(1934).
The dangers of the use of radioactive waters sold by nostrum venders are pointed out. A dosage of 2×10^{-6} g. of Ra has been known to be fatal.

554   Marques, B. E. "Distribution of Radium in Crystals of Radiferous Barium Bromide." Compt. rend. 198, 819-21(1934).

1934

Two methods show a marked decrease in the relative amts. of Ra from the center to the periphery of a crystal of $BaBr_2.2H_2O$ contg. $RaBr_2$.

555   Nikitin, B. A. "A Qualitative Reaction for Radium." Compt. rend. acad. sci. U. R. S. S. (2), 1, 19-20(1934).
Ra is sepd. from Ba by pptn. with 10% K_2CrO_4 in the presence of 1.5% trichloroacetic acid. The method is applicable only in narrow limits in concn.

556   Polesitzkii, A. "Distribution of Radioactive Elements between Liquid and Crystalline Phases. Distribution of Radium between a Solution and Crystals of Barium Chloride in the Presence of Hydrochloric Acid." Compt. rend. acad. sci. (U. R. S. S.) (2), 2, 483-5(1934).
In a study made by Marques on the distribution of Ra in the solid and liquid phases, in the fractional pptn. of $BaCl_2$ in the presence of HCl, the conclusion was reached that the "partition factor", D, is a function of percentage of $BaCl_2$ pptd. However, the acidity of the soln. in this case varied and this variation might have affected the distribution of the Ra. P. repeated Marques' work by pptg. $BaCl_2$ from solns. of various HCl contents and then checked the results by crystg. equal amts. of $BaCl_2$ from supersatd. solns. contg. various amts. of HCl. He found that D is independent of percentage pptn. of $BaCl_2$, but is a function of the compn. of the phases, i.e., the acidity of the soln. in this case.

557   Russell, H. N. "The Spectrum and Ionization Potential of Radium." Phys. Rev. (2), 46, 989-90 (1934).
A new interpretation of the connection between the 2 groups of terms in RaI found by Rasmussen is suggested and confirmed by new observations by Rasmussen (privately communicated). Certain term designations are altered. The first ionization potential is 5.252 v.

1935

558   Isenburger, H. R. "The Protection of Radium Workers." Metals Alloys 6, 100(1935).
A Pb-lined container is described for transporting Ra.

559   Korvezee, A. E. "Determination of the Radium Contents of Different Substances." Chem. Weekblad 32, 726-31(1935).
A lecture reviewing methods for Ra detn.

560   Rozental, Maurice. Support for Radium Salts During Charging of a Liquid or Gas. French Pat. 792,192 (1935).

1936

561   Goldschmidt, B. "Distribution of Radium and its Isotopes in Crystallization of Barium Chlorate." Compt. rend. 203, 619-20(1936).
The possibility that the distribution of the radioactive isotope between crystals formed from a satd. soln. of $Ba(ClO_3)_2$ to which the radioactive isotope had been added, and the remaining soln. might vary according to the isotope has been examined by crystg. $Ba(ClO_3)_2$ to which had been

1936

added Ra(Ra^{226}), AcX(Ra^{223}), and ThX(Ra^{224}) and detg. the activities of the products. No difference beyond exptl. error was found.

562   Hulubei, H. "L Spectrum of Radium." Compt. rend.
       203, 399-400(1936).
   Of the L spectrum of Ra 21 lines (643.7$_9$ -- 1164.7$_7$X.) were measured.

563   Hulubei, H. "L Spectrum of Radium." Compt. rend.
       203, 542-3(1936).
   Three addnl. (fainter) lines of the L spectrum of Ra were detd., also the adsorption spectrum of which the 2 strongest discontinuities had been measured by de Broglie. Lastly the frequencies of 3L, 5M, 6N, 5O and 1P level, based on the exptl. value of L$_{III}$, have been calcd.

564   Marques, B. E. "The Fractionation of Barium
       Salts Containing Radium." J. chim. phys. 33,
       1-40(1936).
   Numerous expts. were carried out to det. the distribution of Ra between the liquid and solid phase when Ra-Ba chlorides, bromides, sulfates, nitrates and carbonates were crystallized by cooling the satd. soln., by keeping the soln. at constant temp. with and without stirring and by fractional pptn. Under all these conditions the equation of Doerner and Hoskins apparently applies exactly. Secondary factors may modify the distribution found experimentally by yielding a nonuniform crystalline mass and then the equation of Berthelot and Nernst may apply. Solid solns. of salts of Ba and Ra and in general the solid solns. of isomorphous salts are not homogeneous mixts. of their constituents except in the very special case.

565   Marques, B. E. "Distribution of Radium in the
       Crystals of Salts of Radiferous Barium." J. chim.
       phys. 33, 219-25(1936).
   Three methods were used: photography, soln. of successive fractions, slow crystn. By each test there was a nonuniform distribution of Ra with a greater concn. in the center than in the surface of the crystals.

566   Marques, B. E. "New Method of Separation of
       Radium from Barium." J. chim. phys. 33, 306-12
       (1936).
   The chloride or bromide of radiferous Ba is dissolved in H$_2$O and the soln. allowed to evap. at 20° until the crystals formed contain about 60% of the original Ba. These crystals will contain about 99.5% of the Ra originally present. They are washed, redissolved in pure water and allowed to evap. until the crystals contain about 60% of the Ba of this soln. They will contain about 99.0% of the original Ra. This process can be repeated as often as desired. After 9 times the salt will contain about 1% of the original Ba and 95% of the original Ra. By this method only one series of crystns. is necessary and the no. of crystns. is reduced.

567   Polesitzkii, A. and Tolmachev, P. I. "Solubility and
       Activity of the Halates of Some Bivalent Metals. III.
       Solubility and Activity of Ra(IO$_3$)$_2$ in Water and in
       Solutions of Electrolytes." Compt. rend. acad. sci.
       U. R. S. S. (2), 3, 319-20(1936).

1936

   The soly. of Ra(IO$_3$)$_2$ in H$_2$O from 0° to 100° ranged from 0.000305 mol./1. to 0.00296. Its soly. in concd. solns. of KNO$_3$, Ca(NO$_3$)$_2$ and KIO$_3$ at 25° was detd. for different concns. of electrolyte. The limiting soly. of Ra(IO$_3$)$_2$ and the activity coeff. at different ionic strengths were calcd.

568   Rosenthal, M. and Grace, E. J. "Experimental
       Radium Poisoning. I. Bone Marrow and Lymph-
       Node Changes in Rabbits, Produced by Oral
       Administration of Radium Sulfate." Am. J. Med.
       Sci. 191, 607-18(1936).
   The general features of radium poisoning as observed in human cases have been reproduced in rabbits by oral administration of radium sulfate. Jaw necrosis, a characteristic of the early acute cases among radium dial painters, can be produced experimentally by radium alone without mesothorium. In the bone marrow striking changes are produced, consisting of an early hyperplasia of the erythropoietic elements followed by decreased maturation of erythroblasts and the replacement of these elements by myelocytes. Finally this hyperplastic marrow is gradually replaced by fibrous tissue. In the lymph nodes there is noted an initial stimulation of the stem cells with subsequent damage to these cells resulting in depletion and atrophy of the lymphoid tissue. In the circulating blood an absolute lymphopenia is found. The development of myeloid tissue in lymph nodes and spleen associated with the extreme myelocytic hyperplasia in the marrow suggests that the occurrence of leukemia in x-ray and radium workers may not be a coincidence.

569   Schulze, G. E. R. "The Crystal Structure of
       Radium Fluoride." Z. physik. Chem. B32, 430-2
       (1936).
   Crystallographic investigation of RaF$_2$ shows it crystallizes in the fluorite lattice, C1-type with a lattice const. of a = 6.368 Å. and d = 6.75. The ionic radius of Ra^{++} is 1.52 Å.

570   Smereker, H. and Juris, K. "Measurement of β-
       Radiation from Radium in r. Units." Strahlentherapie
       52, 327-37(1936).
   Measurement by the method described shows the unfiltered β-radiation to be 200 times as strong as the γ-radiation.

571   Vdovenko, V. M. and Samoilovich, A. G. "Appli-
       cability of the Guy Theory to the Case of the Ad-
       sorption of Radium Ions on Glass." Acta Physicochim.
       U. R. S. S. 4, 613-6(1936).
   Adsorption isotherms for Ra ions at concns. from 10^{-7} to 10^{-11} mols./cc. on glass are given for various pH values from 3.0 to 7.0, and are linear when graphed in log-log terms. The log of the adsorption is also almost a linear function of the pH, but falls more rapidly at pH less than 2.5. On the basis of these data, V. and S. conclude that the Guy theory for multivalent ions (cf. Frumkin, Ergebnisse der exakt. Naturw. 235(1938) is applicable to this case also.

572   Vdovenko, V. M. and Samoilovich, A. G. "Appli-
       cability of the Guy Theory to the Case of the Ad-
       sorption of Radium Ions on Glass." J. Phys. Chem.
       (U. S. S. R.) 7, 583-6(1936).

1936

Russian language presentation of information in previous reference.

1937

573   Bakker, C. J. "Number of Neutrons Emitted by a
         Radium-Beryllium Source." Physica 4, 723-9(1937).
The no. of neutrons emitted by a Ra-Be source (94.33 mg.
Ra + 2 g. pulverized Be), to be used as a lab. standard, is
2.1×10^4 neutrons per millicurie Ra as detd. by the method
of Amaldi and Fermi.

574   Damianovich, H. "The Law of Production of Helium
         by Radium; Results Obtained up to the Present Time
         and New Experiments." Anales soc. cient. argentina
         124, 229-34(1937).
Tabulated data show the wide discrepancies in the re-
sults of expts. on the production of He by Ra from 1905 to
the present time. The need for continued investigation is
indicated.

575   Damianovich, H. "The Law of Production of Helium
         by Radium; Results Obtained up to the Present Time
         and New Experiments." Ann. acad. brasil. sci. 9,
         257-62(1937).
This article contains the same information as the preceding
reference.

576   Dementi, V., Leipunskii, A., and Maslov, V.
         "Neutron Yield Ra γ + Be Photoneutron Source and
         Capture Probabilities for Photoneutrons in Rhodium
         and Silver." Physik. Z. Sowjetunion 12, 764-5(1937).

577   Eichbaum, F. "The Histological Change in the Eye
         of the Dog by Intraocular Injection of a Radium
         Chloride Solution." Strahlentherapie 59, 90-103
         (1937).
1-1½ millicuries produced inflamation of the entire eyeball,
particularly the ciliary and papillary regions. The end result
was an extensive destruction of the retina as far as the
pigment epithelium. No effect was produced by ¼ mc. and only
a slight one by ½ mc.

578   Ershova, Z., Nikol'skii, V., and Rozenblyum, A.
         "Distribution of Radium between Barium Chloride
         and Barium Sulfate at High Temperatures." Redkie
         Metal. 7, 37-9(1938).
After fusing mixtures of $BaSO_4$ and $BaCl_2$ at 700-1040°,
the Ra : Ba ratio is greater in the chloride than in the sulfate;
the difference increases with increase in the fusing temp.

579   Gorshkov, G. V. and Ionov, V. N. "Method of
         Identifying Radium, Mesothorium I and Radiothorium
         in Sealed Preparations." Compt. rend. acad. sci.
         U. R. S. S. (2), 17, 15-18(1937) (in English).
A method is described which is based on the production of
the nuclear photo-effect in heavy H by mesothorium I, and
in Be by Ra. The results agree fairly well with those ob-
tained by the emanation method.

580   Haissinsky, M. "Electrolysis of Salts of Barium
         and of Radium in Acetone." J. chim. phys. 34,
         321-6(1937).

1937

Acetone solns. of BaI_2 and $Ba(CNS)_2$ were electrolyzed at
1 mg./sq. cm., with Pt, Au, Ni or Cu cathodes. Ag was best
as anode. A thin adherent layer of Ba (as carbonate, etc.)
0.1 to 1 mg./sq. cm. was obtained. This layer was very
uniform in structure and very fine grained. Ba was pptd.
quantitatively. Mixts. of Ba and Ra iodides and thiocyanates
behaved similarly, the 2 metals being deposited simultane-
ously. The thiocyanates are somewhat better to work with.

581   Merkulova, M. S. "Distribution of Radium Between
         Crystals and Solution of Difficult Soluble Salts."
         Trav. inst. état radium (U. S. S. R.) 3, 141-9(1937).
A study of the systems $Ba-RaCrO_4$, $Pb-RaSO_4$ and $Ba-RaSO_4$
reveals that the distribution of Ra between the solid and
liquid phases attains true thermodynamic equil. if the
solubilities of $BaCrO_4$, $PbSO_4$ and $BaSO_4$ are increased
slightly by the method of slow crystn. with stirring.
Numerous tables and soly. data. Forty-five references.

582   Nikitin, B. A. "Studies on the Analytical Chemistry
         of Radium. II. Reactions of Pure Radium." Trav.
         inst. état radium (U. S. S. R.) 3, 228-37(1937).
Ra resembles Ba very closely in many of its chem.
properties. A difference greater than usual is found in the
soly. of the chromates and carbonates of the two elements.
The soly. of $RaCO_3$ at room temp. in a concd. soln. of
$(NH_4)_2CO_3$ and NH_4Cl is about ten times greater than that
of $BaCO_3$. The reaction, within very narrow concn. limits,
may be used for the qual. sepn. of the two elements. Some-
what better results are obtained if the two reactions are
combined. If the Ra soln. (not the reverse) is added at room
temp. to a soln. contg. carbonate and chromate ions in the
mol. ratio 23.6, $RaCrO_4$ ppts. quantitatively. Under analogous
conditions, Ba ppts. quantitatively as $BaCO_3$. $Ba-CrO_4$ can
also be partially converted to $BaCO_3$ by heating with 0.2%
Na_2CO_3 soln., while pure $RaCrO_4$ remains unchanged.
Neither of these reactions can be used to effect quant.
sepn. of the two elements from their mixts., as both the
chromates and carbonates of Ba and Ra form solid solns.

583   Rosenthal, M. "Experimental Radium Poisoning.
         II. Changes in the Teeth of Rabbits Produced by
         Oral Administration of Radium Sulfate." Am. J.
         Med. Sci. 193, 495-501(1937).
Observations on animals given radium sulfate per os
show that the radium is stored not only in the alveolar bone
of the jaw but also in the teeth themselves, producing a
pronounced alteration of the entire morphologic picture of
the tooth. There is a marked disturbance in calcification,
with resorption of teeth and the formation of ankylosis by the
ingrowth of newly formed bone, which also replaces the
absorbed bone of the alveolar process. The essential changes
in the enamel organ consist of flattening and atrophy of the
ameloblasts, with hyperplasia of the stratum intermedium
and subsequent degeneration and necrosis of the entire
formative structure. The normal pulp tissue is replaced by
abnormal, irregular secondary dentine masses. The sur-
rounding periodontium shows an extreme hyperplasia of
fibroblastic tissue, with invasion of surrounding structures.
The development of cysts arising from epithelial rests in
this membrane is also an interesting finding.

1937

584   Starik, I. E. and Gurevich, A. M. "Adsorption of
        Radium by Glass." Trav. inst. état radium (U. S. S.
        R.) 3, 241-55(1937).

The extent of Ra adsorption by glass from RaBr₂ soln.
contg. 5×10^{-9} g. Ra/cc. apparently depends on the amt. of
impurities present. In a carefully purified soln. the degree
of adsorption remains const. in the range pH = 6.5 to 4.5.
Further increase in acidity sharply lowers the adsorption,
which becomes practically negligible at pH = 2.3. The data
for slightly alk. media (pH = 7.9) cannot be compared with
those for acid media because of the possible presence of
colloid particles (SiO₂, etc.) in the alkali used. Change in
adsorption with time is greatly dependent upon the impurities
present in the soln. and is probably due to the presence of
complex colloid particles on which Ra is adsorbed.

585   Starik, I. E. and Segel, N. M. "Radiochemical
        Analysis of Khlopinite. II. Leaching of Radium and
        Uranium from Khlopinite." Trav. inst. état radium
        (U. S. S. R.) 3, 218-26(1937).

Expts. on the leaching of Ra and U from khlopinite reveal
that the leaching of Ra in neutral, slightly acid, and alk.
media is considerably greater than that of U.

586   Tolmachev, P. I. "Practical Coefficient of Crystal-‘
        lization in High-Percentage Barium-Radium
        Bromides." Trav. inst. état radium (U. S. S. R.) 3,
        239-40(1937).

For Ra-Ba solns. rich in Ra the crystn. coeff. of RaBr₂
(concn. of RaBr₂ in ppt./concn. of RaBr₂ in soln., as detd.
by γ-ray analysis), detd. by evapn. of strongly acid solns.
(4-5N HBr) to incipient crystn., is 2.19. This value is
approx. 1/7 of that found for very weak Ra solns.

1938

587   Engstrom, S. R. A., Metallges, A.-G. Concentrating
        Radium Compounds. German Pat. 658,254 (1938).

Ores or other materials contg. compds. of Ra are heated
with a chloride to a temp. sufficiently high to effect vapori-
zation of RaCl₂. The vaporized products are freed from dust,
preferably by electrofiltration, at above 500° and then cooled
to about 30° to condense RaCl₂, which is recovered, preferably
by wet electrofiltration.

588   Føyn, E., Gleditch, E., and Hanneborg, S. "The
        Precipitation of Radium as Sulfate." Arch. Math.
        Naturvidenskab. 41, No. 12, 10 p. (1938).

The efficiency of the pptn. of Ra in radiferous solns. of
BaCl₂, on adding increasing quantities of sulfate ion (K₂SO₄)
and varying the concn. of the Ba with respect to the Ra, is
studied. By progressively increasing the quantities of the
sulfate ion in a soln. of the chlorides of Ba and Ra the latter
is preferably pptd. at the beginning. When the quantity of the
sulfate ion exceeds a third of that of the equiv. quantity of
Ba, the pptn. of the Ra becomes relatively less good. It is
more complete in dil. solns. and reaches a max., when the
mol. quantity of the sulfate ion is equal to a third of that of
the Ba present. By increasing the quantity of Ba in pro-
portion to the Ra, the pptn. is less complete. In sea water,
i.e., a soln. containing sulfate ion from the beginning, the
addn. of a very small quantity of BaCl₂ causes a great
diminution of the Ra in soln. Its pptn. becomes practically

1938

complete, when the quantity of added Ba reaches a quarter
of that of the equiv. sulfate ion present. On the other hand,
when the mol. quantity of Ba exceeds that of the sulfate ion,
a part of the Ra remains in soln. Likewise an excess of Ba
tends to keep the Ra in soln. The presence of Ca salts, too,
impedes the pptn. of the Ra.

589   Føyn, E., Gleditsch, E., and Hanneborg, S. "Precipi-
        tation of Barium and Radium with Thorium X as
        Indicator." Mikrochim. Acta 3, 253-7(1938).

A method has been developed which makes it possible to
det. the rate of pptn. of ThX(Ra²²⁴) in solns. contg. (SO₄)⁻⁻
ions. The amt. of ThX is detd. rapidly and accurately by
the Th emanation (thoron) evolved under fixed conditions.
Detns. were made every 5 min. during the period following
pptn. and the results are shown graphically. They show
very clearly that the pptn. of ThX requires a certain length
of time which depends on the concn. of the (SO₄)⁻⁻ and Ba⁺⁺
solns. and upon the presence of other ions. If equiv. quantities
of Ba⁺⁺ and (SO₄)⁻⁻ are used, the final result is always the
same. The app. described is suitable for detg. the Th
content of spring waters.

590   Goldschmidt, B. "Fractionation of Radium in the
        Precipitation of Barium Iodate from Different So-
        lutions of Radiferous Barium Salts." J. chim. phys.
        35, 407-13(1938).

The coeff. of fractionation (quotient of the ratios of micro
compd. to macro compd. in the solid and in the liquid phases)
for the pptn. of Ba-AcX(Ra²²³) iodate from aq. solns. of the
salts by means of KIO₃ increases with the concn. of the soln.
(decreases with BaBr₂ above 2M) and with the strength of the
anion at const. concn., and with the ionic strength of the
soln. when other salts are present. The coeffs. of fractionation
detd. in the above cases vary from 1.63 to 2.54. The re-
sults agree qualitatively with the theory of Ratner. The re-
sults of Polesitzkii and co-workers are criticized.

591   Gorshkov, G. V., Ljatkovskaya, N. M., Grammakov,
        A. G., and Zhadin, V. S. "The Neutrons of Rocks."
        Compt. rend. acad. sci. U. R. S. S. (2), 19, 499-502
        (1938).

Observations were made with a Ag counter to compare
the effects of a rock contg. 0.2 % of U₃O₈ and an artificial
Ra-Be prepn. with an energy of 0.3 millicurie. Approx. the
same ratio of neutrons to γ quanta was obtained from the
rock as from the Ra-Be prepn. The rock emits approx. one
neutron per 2000 γ quanta. From a rock with a radioactivity
of about 10^{-2} g. Ra/G. about 2 neutrons/hr./cm.² of counter
surface were to be expected, when fast neutrons were
counted.

592   Gorshkov, G. V. "The Determination of the Con-
        tent of Radium, Mesothorium and Radiothorium in
        Weak Preparations by Secondary β-Rays and Con-
        nected Geiger-Mueller Counters." Trans. inst.
        état radium (U. S. S. R.) 4, 83-115(1938).

The prepns. are sealed in glass tubes. The secondary β-
rays excited by the γ-rays are passed through a Geiger-
Mueller counter and then through Al screens 0.003-0.81 mm.
thick and then into the 2nd counter. The variation in pene-
trating power of the β-rays from the 3 elements permits their

detn. The method gives an accuracy of about 15% in the best case, as compared with 1% when γ-rays are used, but it permits the use of concns. of the elements equiv. to 0.1 g. Ra. The electron absorption curves vary with the concn. of the elements, and if the concn. of 2 elements in a mixt. differs 10-fold, errors of 3-4% are introduced. Filtration of the γ-rays by a 2-cm. Pb filter increases the hardness of the β-rays. The distance from the prepn. to the counter has little effect on the electron-absorption curve.

593   Hove, V. "On the Radiation Potential of the Blood and Other Tissues Following Radium Injection." Strahlentherapie 61, 300-08(1938).

The author studied the radium content of the blood following intraven. inj. of 0.01 to 0.03 mg. in humans by means of photographic films. In some cases the Ra content dropped very rapidly on the 4th day. In others the drop occurred rather gradually. 2 mos. later there was still definite blackening of the film. Following subcut. inj. of Ra solns. the Ra content of the blood reaches its peak 24 hrs. later. During the first few days following the inj. the adrenals, bone marrow, kidneys, spleen, liver, lungs, pancreas, and uterus contain Ra. Several wks. later it is still found in the liver, spleen and bone marrow.

594   Janitzky, A., Krebs, A., and Rajewsky, B. "Researches on the Problem of Radium Poisoning. II. Experimental Determination of Radium Deposits in the Human Body." Strahlentherapie 61, 254-68 (1938).

By measuring the emanation with a specially constructed Geiger counter it was possible to record the absolute amt. of Ra deposits, the distr. in the various tissues of the body and the emanation emitted. Very small amounts of radioactive substances, as little as 1 μg., in the body sufficed to produce irreparable damage. This could be explained by the intense biologic effect produced by the α-rays which were totally absorbed as well as by the complete accumulation.

595   Lakhani, J. V. and Daroga, R. P. "Determination of the Parachors of Inorganic Salts in Solutions. III. The Parachors of Some Salts of Magnesium, Strontium and Barium and the Atomic Parachor of the Above Elements and Radium." J. Indian Chem. Soc. 15, 604-7(1938).

The graph obtained by plotting the log of the at. no. of Mg, Sr and Ba vs. the log of the parachor is a straight line. Parachors detd. were 57.7, 85.8 and 106.2, resp. The at. parachor of Ra found by extrapolation was 140.

596   Meyer, S. "The Radioactive Constants of Uranium and Radium." Anz. Akad. Wiss. Wien, Math.-naturw. Klasse 75, 7-11(1938).

The best values for at. wt., disintegration const., half-life, no. of α/sec. are, resp.: for UI 238.10, 1.51×10^{-10} yr.$^{-1}$ 4.58×10^9 yr., and 1.214×10^4: for Ra 226.07, 4.38×10^{-4} yr.$^{-1}$, 1.59×10^3 yr., and 3.7×10^{10}.

597   Ollano, Z. "Production of Photo-Neutron by a Ra-Be Source." Nuovo cimento 15, 541-50(1938).

The number of neutrons emitted by a Ra-Be source is determined by a method developed by Amaldi and Fermi in which the density of neutrons of thermal velocity is measured

1938

at different points with a Rh detector and calibrated Geiger-Mueller counter when the source is surrounded with water. The average cross-section for the nuclear photo-effect of the harder γ-rays of RaC in Be is found as $(2.0 \pm 0.3) \cdot 10^{-27}$ cm^2., in good agreement with measurements of Dementi and Frisch and their co-workers (see Nature 140, 895(1937) and Physik. Z. Sowjetunion 12, 764(1937).)

598   Ollano, Z. "The Neutron Yield from a Ra α + Be Source." Rend. ist. lombardo sci. (2), 71, 341-5(1938).

The neutron yield of a Ra + Be cell is compared with that of a Rn + Be source and is found to be about 83% of the latter. This difference is due to the fact that the α-particles emitted by Ra have a smaller energy. Furthermore the contact between solid salt and Be is less intimate than in the case of the gas.

599   Polesitzkii, A. and Karataeva, A. "Thermodynamic Study of the Distribution of Radium Between Crystals and Solutions of Barium Iodate." Acta Physicochim. U. R. S. S. 8, 251-7(1938).

Results obtained at 0° and 24° are in good agreement with Ratner's theory. At 78° and 100° some deviations were observed, probably because equil. was not attained. The "true distribution coeff." D_0, calcd. from the exptl. values of the distribution coeff., D, was nearly const.

600   Segel, N. M. "The Geochemistry of Uranium and Radium. The Leaching of Uranium and Radium from Minerals." Trav. inst. état radium (U. S. S. R.) 4, 350-84(1938).

Ra is extd. from torbernite, and less easily from khlopinite, when the minerals are allowed to stand in H_2O for long periods of time. Under these conditions almost no U is extd., although at high temp. or in acid solns., in which the crystal structure of the mineral is destroyed by soln., the amt. of U extd. increases. Ra extn. is proportional to surface area of the mineral. When several extns. are made of the same mineral sample, the amt. of Ra extd. is less in the later expts. Ra extn. is increased when ions are added to the soln. The order of their activity is H > Ba > Pb > Ca > K > Na, but the last 3 are only slightly active. ThX(Ra^{224}) is easily extd. from minerals by H_2O, but radiothorium is not affected.

601   Sizoo, G. J. and Willemsen, H. "Absorption of the γ-Rays of Radium." Physica 5, 100-4(1938).

From the theories of scattering, photo-absorption and the creation of pairs, the total absorption coeffs. for the $\lambda\lambda$ corresponding with the various components of the γ-radiation of Ra are calcd. and, with the help of exptl. intensities of these components, the absorption curves for Al, Fe, Cu, Sn and Pb are found. Results are in agreement with the absorption measurements of Kohlrausch.

1939

602   Baranov, V. I. "Assimilation of Radioactive Elements by Plants." Compt. rend. acad. sci. U. R. S. S. 24, 951-4(1939).

The test plants were the pea, lettuce, cucumber, flax and oat. They were grown in water and sand cultures supplied with the necessary nutrients and with varying concs. of Ra,

1939

U, and Ac containing radioactive elements. The absorption of these elements is discussed.

603   Chininfabrik Braunschweig Buchler, Co. Radium Tabloids. German Pat. 677,958 (1939).
Finely divided Ra-Ba salts of higher fatty acids are homogeneously dispersed in molten paraffin so that a practically single-phase product results on congealing.

604   Curtiss, L. F. "Internal Absorption of γ-Rays in Ra-Be Neutron Sources." J. Research Nat. Bur. Standards 23, 617-19(1939).
When neutron sources composed of Be powder mixed with a Ra salt are prepared commercially, it is sometimes desirable to determine the actual amount of Ra in such a source by γ-ray comparisons with a Ra standard. To do this it is necessary to know the amount of absorption of γ-rays within the source and its container. To compute this correction, a knowledge of the absorption coefficient of the Be powder is required, and the equations involved are difficult to work with in the case of a cylindrical source such as is commonly used. Therefore, this internal adsorption has been determined experimentally for a source contained in a brass cylinder of 8-mm. internal dia. and 24.5-mm. internal length with wall 1 mm. thick. This cylinder contained a mixture of 1,237 mg. of finely powdered Be and $RaSO_4$ (139.7 mg. of Ra). From measurements made in the usual way with a γ-ray electroscope with 1 cm. of lead filtering, the absorption correction was found to be 5.1%.

605   Gunther, P. "The Formation of Helium from α-Rays. II. The Determination of the Decay Constants of Uranium and Radium." Z. physik. Chem. A185, 367-74(1939).
Expts. with Ra lasting for 100-150 days gave an av. of 1.36×10^{-12} cc./He/g. Ra/sec.; this corresponds to the emission of 3.67×10^{10} α-particles/sec./g. Ra and to a decay const. of 4.35×10^{-4} years^{-1}. These values are in good agreement with the results of detns. by other means.

606   Janitzky, A. "Determination of Radium in Powerfully Emanating Preparations by Measuring the Emanation 'in statu nascendi.'" Kolloid-Z. 89, 316-19(1939).
A stream of air is bubbled at a const. rate through or over the Ra contg. prepn. into an evacuated ionization chamber. After about 25 min., a steady state is reached in which emanation is carried over as fast as formed, and from a measurement of the amt. of emanation carried in a given time, the amt. of Ra present is readily calcd. The method is less time-consuming and nearly as accurate as the older methods.

607   Kaiser, H. F., Jr. Report on The Fogging of Photographic Materials by Radiographic Radium. Naval Research Laboratory. July 25, 1939. (NRL-M-1547).
A variety of commercial photographic and X-ray films were exposed under conditions simulating actual shipping conditions at several distances from a standard 250 milligram radium capsule enclosed in its lead carrying case. The exposures required in each case to produce a density gain of 0.07 were determined and a table was constructed giving the permissible transit times for each kind of film when 15 feet

1939

from the radium unit. These values are at the least several times those permitted for the same conditions by present railway express regulations.

608   Khlopin, V. G. "Adsorption of Radium on Lead Sulfate." J. Phys. Chem. (U. S. S. R.) 13, 1154-5 (1939).

609   Kumasheva, K. G. "Distribution of Radium and Uranium in Plants Raised on Media with Different Concentrations of These Elements." Trav. lab. biogeochim. acad. sci. U. R. S. S. 5, 197-200(1939).
Peas (pisum sativum) were raised on Helriegel's solution with an addition of solutions containing 1.45×10^{-11} to 1.45×10^{-8} g. of Ra (as $RaCl_2$) repeatedly checked by the emanation method. To another series were added solutions containing 4.73×10^{-5} to 4.73×10^{-2} g. of U (as uranic nitrate). Ra penetrates into all parts of the plant in a concentration proportional to the concentration of Ra in the nutrient medium. U could not be found in the green parts. Plants grown in weak U solutions had taken up the U almost quantitatively in the roots. In those grown in solutions containing 100 times more U the amount in the roots had only tripled.

610   Nahmias, M. E., Hopwood, F. L., Banks, T. E., Rann, W. H., and Grimmett, L. G. "Apparent Existence of a Very Penetrating Radiation from Radium and (Radium + Beryllium)." Nature 143, 1065-6(1939).
A penetrating radiation from Ra was previously supposed to consist of mesotrons. It was shown to be due entirely to γ-rays excited by neutrons in the Pb protection around the counter, in the brass wall of the counter, and in the air inside it.

611   Nakai, Tosio. "The Methods of Determination of Radium in Rocks." J. Chem. Soc. Japan 60, 126-32(1939).
The accuracy of so-called emanation methods of detg. Ra in rocks is discussed.

612   Ollano, Z. "Salts of Radium Mixed with Beryllium as a Source of Neutrons." Nuovo cimento 16, 456-8 (1939).
Comparison of the number of neutrons emitted/sec./mc. by two sources composed of mixtures of Ra salts with Be revealed a significant difference which was traced to faulty mixing in one case.

613   Polesitzkii, A. and Ratner, P. "A Method for Preparing Neutron Sources of Long-Time Action." Compt. rend. acad. sci. U. R. S. S. (2), 24, 250(1939).
A soln. of a Ra or RdTh salt is mixed with a neutral soln. of 0.8 g. $BeCl_2$ in 200 ml. H_2O and also with approx. 2 g. of metallic Be. A soln. of NH_4OH (contg. some Na_2SO_4 in the case of the Ra salt) is added with vigorous stirring. After 15 min. the ppt. is filtered off, dried at 110° and then ignited at 300°. The resulting powder of Be + BeO is placed in a gilded metallic tube and carefully soldered shut to avoid any diffusion of Rn or thoron. Compared with the usual Rn + Be source, the Ra prepn. has an intensity of 0.8; that of the RdTh prepn. is 1.2.

1939

614   Rajewsky, B. "Researches in the Problem of
        Radium Poisoning and the Tolerance Dose of
        Radium." Radiology 32, 57-62(1939).
    The distr. of radium in various tissues was detd. in
2 cases of radium poisoning. The normal radium content
of the human body is 1.5×10^{-8} g. A dose of 1.5×10^{-5}
curie-hrs. will alter metabolism. The lethal dose is
one γ of radium equivalent.

615   Wallbach, G. "Action of Benzene and Thorium-X
        on Leucocytes." Sang, Le 13, 719-38(1939).
    W. reviews his previous studies on ThX(Ra^{224}) and
benzene poisoning and their effects on the circulating
blood and the hematopoietic organs. An extensive
bibliography is listed.

1940

616   Chamié, C. "The New International Ra Standard."
        J. Phys. radium (8), 1, 319-21(1940).
    The ratio of γ-radiation of the new Ra standard to the old
is 1.023, thus 2% higher than the ratio of their weight, which
amounts to 1.021.

617   Drobkov, A. A. "The Influence of Radioactive Ele-
        ments on the Yields of Plants." Bull. acad. sci.
        U. R. S. S., Ser. biol. 783-801(1940).
    The yields of flax, peas, alfalfa and cucumbers were
considerably increased by the addition of small amounts of
Ra, U, Th and Ac to the nutrient solutions. As the Ra and U
contents of the nutrient solutions were increased, the content
of the plants in these elements also increased. The absorption
coefficient, however, was not the same in nutrient solutions
of different concentration. Ra and U were best absorbed
from solutions in which they were present in the smallest
amounts. Ra was absorbed during the whole vegetative
period, although the most intensive absorption occurred
during the period of blooming and fructification. The positive
effect of the radioactive substances on the plants was evident
chiefly in the production of more seed and an acceleration of
the maturing process. Ra, U and Th are usually present in
soils in amounts which are large in comparison to their
consumption by plants, although there are soils on which
an increase in yield can be obtained by the addition of Ra,
U and Th.

618   Franz, H. and Weiss, C. "Calculation of Absorption
        in Highly Concentrated Preparations of Radium."
        Physik. Z. 41, 345-8(1940).
    Mathematical. A method is devised for correcting for
self absorption.

619   Goldschmidt, Bertrand. "A Study by Means of
        Radioactive Elements of Fractionation by Mixed
        Crystallization." Ann. chim. 13, 88-174(1940).
    In the syncrystn. of 2 salts possessing a common ion,
the fractionation is conditioned by the differences of
properties of the 2 substitutable ions. The coeff. of
fractionation is defined and measured experimentally in
this study. It is the quotient of the ratios of the concns. of
the 2 components in the crystal phase and in the soln. when
the quantity of material crystd. is sufficiently small so that
the compn. of the soln. remains practically unchanged during

1940

crystn. The study of the triple mixed system of the sulfates
of Ba, Sr and Ra has a very practical significance. It is
proposed to use Sr in place of Ba for the extn. of Ra from
minerals. Sr is capable of giving mixed salts with Ra, and
it can be sepd. much more easily than Ba by fractional pptn.
of their sulfates.

620   Goloborod'ko, T. A. and Leipunskii, A. I. "Scattering
        of Photo-Neutrons of Different Energies by Atomic
        Nuclei." Bull. acad. sci. U. R. S. S. Ser. phys. 4,
        317-19(1940). (Translated as Document N-1823)
    The form and preparation method for RaTh-D and RaTh-
Be neutron sources used is indicated. Cross section measure-
ments with these sources and comparative values for Ra-Be
source are given for 36 elements.

621   Goloborod'ko, T. A. "Angular Distribution of
        Photoneutrons (Rd-Th+Be)." J. Exptl. Theoret.
        Phys. (U. S. S. R.) 10, 835-6(1940).
    With neutrons extd. from Be by γ-rays of RdTh, the ratios
of angular intensities are found to be: $I_{90°}/I_{0°} = 1.75 \pm 0.04$
and $I_{180°}/I_{0°} = 1.03 \pm 0.05$; identically, for photo-neutrons
(RdTh + D), extd. from D_2O, the corresponding ratios are,
resp., 1.71 ± 0.04 and 1.05 ± 0.06. These distributions are
contrasted with the spherical symmetry of the angular
distribution of photo-neutrons (Ra + Be).

622   Goloborod'ko, T. A. "Angular Distribution of
        Photoneutrons (Rd-Th+Be)." J. Phys. (U. S. S. R.)
        3, 141-2(1940).
    With neutrons extd. from Be by γ-rays of RdTh, the ratios
of angular intensities are found to be: $I_{90°}/I_{0°} = 1.75 \pm 0.04$
and $I_{180°}/I_{0°} = 1.03 \pm 0.05$; identically, for photoneutrons
(RdTh + D), extd. from D_2O, the corresponding ratios are,
resp., 1.71 ± 0.04 and 1.05 ± 0.06. These distributions are
contrasted with the spherical symmetry of the angular
distribution of photoneutrons (Ra + Be).

623   Kabakjian, D. H. "Luminescence of Pure Radium
        and Barium Compounds." Phys. Rev. (2), 57, 700-5
        (1940).
    Heated crystals show an intensity several hundred times
that of unheated crystals. A max. temp., however, exists,
above which the intensity again diminishes. This max. temp.
is not related to m.p. or cryst. form.

624   Lieseberg, C. "Radioactive Investigations on So-
        lutions and Powders." Z. Physik. Chem. B47,
        269-87(1940).
    Addn. of sulfates and carbonates that form solid solns.
with $RaSO_4$ and $RaCO_3$ results in a decrease in the ema-
nation power of the solns. Addn. of Cu or Bi to ZnS or
CaS phosphors reduces their phosphorescence. Two dif-
ferent emanation absorption expts. show the effect to be due
to formation of large centers around the heavy metals.

625   Murphy, E. J., Bright, W. C., Whitaker, M. D.,
        Korff, S. A., and Clarke, E. T. "Comparative
        Efficiencies of Radioactive Neutron Sources."
        Phys. Rev. (2), 58, 88(1940).
    It is usually assumed that neutron production from Ra-Be
and Rn-Be sources is proportional to γ-ray intensity. By
assigning the highest proportional yield of neutrons a value of

1940

1, values of 0.88-1.00 were found for 4 Ra-Be sources (9.87-200 mg.), and 0.55-0.76 for 2 Rn-Be sources (60 and 30 mC.). A serious error may be made by assuming neutron yield to be proportional to γ-ray intensity.

1941

626   Drobkov, A. A. "Effect of Radioactive Elements (Ra) and Rare Earths (TR) upon Yield and Rubber Content of Kok-Saghyz." Compt. rend. acad. sci. U. R. S. S. 32, 667-8(1941).

Plants were grown in 10 kg. of pure sand with rare earths (as nitrate) added in concentrations of 2.5×10^{-3} and 2.5×10^{-2} and radium (as chloride) 10^{-9} and 10^{-8} g. and in addition a normal solution of Hellriegel + 10 mg. H_3BO_3 + 10 mg. $MnSO_4$. At rosette formation all plants again received N, P and K. With no boron and manganese in the Hellriegel solution, root yield and rubber content is low. A small increase of root yield occurs in the presence of rare earths, but a 72.2% and 101.82% increase in rubber content with the two concentrations. Radium is more effective than rare earths in increasing the yield, but less effective on rubber content.

627   Goloborod'ko, T. A. "Spectra and Energy of (Rd-Th, Be) and (Ra, Be) Photo-Neutrons." J. Exptl. Theoret. Phys. (U. S. S. R.) 11, 615-19(1941).

G. investigated the spectrum of photoneutrons RdTh + Be and Ra + Be by filtering of these photoneutrons through paraffin slabs of various thicknesses. By this filtration it was shown that neutrons of the first reaction are mono-chromatic; however their energy is approx. half of the generally accepted value, i.e., 0.45 mev. instead of 0.86 mev. Photoneutrons from the 2nd reaction consist mainly of 2 groups with energies of 0.1 and 9.25 mev. The energy of the latter group produced by γ-rays with energy of 2.2 mev. is also found to be less than the accepted value of 0.49 mev. by approx. a half. It was also found that in the spectrum of γ-rays of RaC there exists, until now unknown, a weak line with the energy of the order of 3 mev. Filtering of the photo-neutrons mentioned above to give monochromatic conditions is achieved only by surrounding the detecting device with the requisite amt. of paraffin; omission of this leads to erroneous conclusions in the various measurements with these emis-sions. In both reactions after removal of neutrons from the compd. nucleus of Be, there is left a nucleus Be^8 which then splits into 2 α-particles.

628   Goloborod'ko, T. A. "The Spectra of Photoneutrons (Rd-Th + Be) and (Ra + Be)." J. Phys. (U. S. S. R.) 5, 15-18(1941).

By filtration through paraffin layers of various thicknesses it was found that the photo-neutrons (RdTh + Be) are mono-chromatic and possess an energy of about 0.85 mev. The photo-neutron spectrum of (Ra + Be) contains two groups with energies of 0.1 and 0.5 mev. The scattering cross sections of silicon as measured by these 0.1 and 0.5 mev. photo-neutrons differ considerably. For the Rd-Th + Be photo-neutrons $\sigma \times 10^{24}$ is 4.2 cm.; for the Ra + Be neutrons σ varies from 3.8 for 6 cm. paraffin spheres to a minimum of 1.6 for 13 cm. spheres, and then again increases to 2.6 for 20 cm. spheres.

1941

629   Goloborod'ko, T. A. "Spectra and Energy of (Rd-Th, Be) and (Ra, Be) Photo-neutrons." J. Phys. (U. S. S. R.) 5, 19-24(1941).

G. investigated the spectrum of photo-neutrons RdTh + Be and Ra + Be by filtering of these photo-neutrons through paraffin slabs of various thicknesses. By this filtration it was shown that neutrons of the first reaction are mono-chromatic; however, their energy is approx. half of the gener-ally accepted value, i.e., 0.45 mev. instead of 0.86 mev. Photo-neutrons from the 2nd reaction consist mainly of 2 groups with energies of 0.1 and 0.25 mev. The energy of the latter group produced by γ-rays with energy of 2.2 mev. is also found to be less than the accepted spectrum of γ-rays of RaC there exists, until now unknown, a weak line with the energy of the order of 3 mev. Filtering of the photo-neutrons mentioned above to give monochromatic conditions is achieved only by surrounding the detecting device with the requisite amt. of paraffin; omission of this leads to er-roneous conclusions in the various measurements with these emissions. In both reactions after removal of neutrons from the compd. nucleus of Be, there is left a nucleus Be^8 which then splits into 2 α-particles.

630   Murphy, E. J., Bright, W. C., Whitaker, M. D., Korff, S. A., and Clarke, E. T. "Relative Efficiencies of Radioactive Neutron Sources." J. Franklin Inst. 231, 357-71(1941).

Several Ra-Be and Rn-Be neutron sources are compared. On the basis of the usual assumed ratio of γ-ray activity to neutron production, the Ra sources vary in efficiency by a factor of two, and the Rn sources by 15%. Sources manufd. under similar conditions compare more favorably. For the Ra source, the mixing, the size of the Ra grains and the purity of the Be are important. The geometrical shape of the source and the abs. amt. of Be are not especially im-portant. For the Rn sources, it is in addn. especially im-portant that the container be as full as possible, with as little space as possible occupied by the gas alone. The contribution of photo-neutrons is about 0.2 of the total emission.

631   Nikitin, B. A. and Polesitzkii, A. E. "A New Method for the Separation of Radiothorium and Radium D and for the Purification of Radium-Mesothorium Salts." Compt. rend. acad. sci. U. R. S. S. (2), 33, 494-7(1941).

MsTh and Ra isotopes can be sepd. from Th, Pb, Bi and most other common contaminants by taking advantage of the low volatility of the chlorides of the former in a stream of HCl + CCl_4 at 800°. A 1-hr. treatment volatilizes 80-95% of the RdTh and practically 100% of the ThB, as well as some of the ThC, from active $BaSO_4$. $BaSO_4$ is changed quantitatively to $BaCl_2$ and remains with Ra and $ThX(Ra^{224})$ in the residue. Hexachloroethane is formed from the CCl_4 but can be evapd. readily from the distillate. If the active Ba compd. is $BaBr_2$ or $BaCl_2$ the CCl_4 need not be used. At 500° a current of HCl carries away 30-40% of the ThB per hr. from $BaCl_2$, while RdTh remains quanti-tatively in the residue; however, no addnl. ThB is removed after a 3-hr. treatment. To sep. the isotopes of Pb from RdTh it is best to volatilize the ThB, RaD and RdTh at 800° and then remove the first 2 from the 3rd at 500°. The

1941

volatilized materials can be collected in water or, preferably, in a trap cooled with liquid air. RdTh is adsorbed. strongly on the surface of etched glass, and to a smaller extent on glazed porcelain; it can be removed by rubbing with filter paper wet with a soln. of HF. Less common contaminants (Al, Fe, SiO_2 etc.) are also volatilized in the current of $HCl-CCl_4$; by use of this property Ra adsorbed on hydroxides of Fe, Al, Th, etc., can be recovered. To obtain RdTh systemmatically from concd. prepns. of MsTh it is convenient to keep the latter in a porcelain boat; after 3 months, when the optimal accumulation of RdTh is present, the boat is placed in the furnace for 1-1.5 hrs. to remove the RdTh and is then allowed to stand for another 3 months.

632   O'Neal, R. D. "Comparative Study of Photo-
        Neutron Sources." Phys. Rev. (2), 59, 919(1941).
    The slowing down of the photo-neutrons from 100 mg.
Ra + Be, 100 mg. Ra + D_2O 10 mg. RdTh + D_2O, and
Y + Be were studied by the method of Amaldi and Fermi,
using an In detector. The number of neutrons from this
source surrounded by Be as measured by the integral under
the Amaldi-Fermi curve was compared with the number of
neutrons from Ra + Be measured in the same number. This
ratio was approximately equal to the ratio of the hard
gamma-ray intensities of these sources (as measured
through 6 mm. of Pb). This is in agreement with the result
that the energy of the Y gamma-rays, 1.87 ± .05 mev., is
intermediate between the energy of the Ra gamma-rays
responsible for photo-neutrons. An attempt was made to
determine whether the 2.2 mev. gamma-ray of Ra gives
any appreciable contribution to the neutrons from Ra + D_2O.
A comparison was made between the curves for Ra + D_2O
and RdTh + D_2O and Ra + Be. Curves for both C and D
neutrons were studied but no evidence was found for low
energy neutrons produced by the 2.2 mev. gamma rays.

633   Pinto, S. S. and Bowditch, M. "Medical Progress.
        Industrial Hygiene." New Engl. J. Med. 225, 949-
        52(1941).
    A review of recent studies on poisoning by benzene, CS_2,
TNT, tetryl, Pb, Hg and Ra, methods of treatment and precautionary measures. Thirty-two references.

634   Wolf, P. M. and Born, H. J. "The Distribution of
        Naturally Radioactive Substances in the Organism
        after Parenteral Administration." Strahlentherapie
        70, 342-8(1941).
    Expts. on rats revealed that the ThX(Ra^{224}) content of the
blood decreased very rapidly after intravenous injection of
ThX in isotonic soln. contg. Ca and in the complex org.
form as pyrocatecholdisulfonate. ThX was, therefore,
rapidly excreted or taken up by the tissues. In the organs
most of the ThX was found in the kidneys, intestines and
skeletal parts. The greater part of the ThX in the intestines
was excreted. In spite of the high content in the kidneys,
however, only 1% was excreted in 24 hrs. in human beings.
The distribution of ThX in the organs differed from that of
ThB, evidently because of the difference in chem. nature.
Further expts. showed that ThX was taken up by the tissues
more rapidly after administration in complex form than when
administered as the ion.

1941

635   Wolf, P. M. and Born, H. J. "The Degree of Purity
        of Thorium X Preparations." Strahlentherapie 70,
        349-51(1941).
    Long-lived radioactive substances are injurious to health
when introduced into the organism and must be removed
from the short-lived substances. After the use of the sepn.
processes of W. and B. the short-lived ThX(Ra^{224}) still contains 0.05% radiothorium (I). After the administration of
2-3 mg. ThX, 5-7.5 × 10^{-9} g. I is retained in the human body;
this, in contrast to Ra, however, has a half-life period of (?)
only 1.9 years and is, therefore, not harmful. For the sepn.
of ThX from (I) a faintly acid (HCl) soln., which contains Fe
and Th in addn. to (I), is rendered faintly ammoniacal. Upon
filtration ThX passes into the filtrate, while Fe, Th and I are
retained on the filter. More ThX can be obtained from the
ppt. by resoln. and repptn.

1942

636   Agnew, H. M., Anderson, H. L., Miller, G., Roberts,
        J. H., Whitaker, M. D., and Wollan, E. O. The
        Number of Neutrons Emitted by Ra+Be Source.
        Source II. Experiments in Water Tank. University
        of Chicago. Sept. 7, 1942. (MDDC-878; CP-252;
        A-280)
    The number of neutrons emitted by a Ra+Be source was
measured by integrating the thermal neutron activity of a
standard detector in a water tank. It was found that the
number of neutrons emitted by Source II (10 g. of Be mixed
with 1 g. of Ra) is 14.0 × 10^6 neutrons/second.

637   Anderson, H. L., Fermi, E., Roberts, J. H., and
        Whitaker, M. D. The Number of Neutrons Emitted
        by a Ra-Be Source (Source I). University of
        Chicago. March 21, 1942. (MDDC-880; C-21)
    Three Ra-Be n-sources of from 0.84 to 1.16 g. Ra each
were measured using a BF_3 proportional counter and a
carbon moderator (5 ft. thick). Values of 1.24 and
1.25 × 10^7 m/g. Ra were obtained. Calculation methods
are discussed.

638   Bolton, J. N. Use and Limitations of Radium in the
        Inspection of Castings. Rock Island Arsenal.
        June 1942. 10p. (RIA Lab. Report 42-6087;
        PB-30807)
    Discussion of training of operators and use of 200 mg.
Ra capsules for radiography.

639   Curtiss, L. F. "Protection of Personnel Handling
        Radium." Am. Soc. Testing Materials Bull. No. 114,
        21-4(1942).
    Protection against radium involves the use of long forceps
or other instruments, lead shields, min. time of exposure,
and the use of an exposure meter employing a Geiger-
Mueller tube counter (described) to check the exposure
under changing conditions and to det. safe areas.

640   Gamertsfelder, G. R. I. The Slowing Down of
        Neutrons. II. A Reproducible Standard of Neutron
        Intensity. PhD Thesis, Univ. Illinois. 1942.
        (also bears AEC number N-1178)

1942

Part II describes Ra-Be source consisting of Ra capsule at one end of Al tube with Be block at opposite end. Dimensions and n/mC. Ra given.

641   MacTaggart, E. F. "The Production of Radium." Trans. Inst. Chem. Engrs. (London) 20, 65-71(1942). (Abstracted in Chem. Met. Eng. 50, 178-81(1943).

This article describes processes used for the leaching of various radium ores, methods for the determination of the radium content of a salt or ore, and the separation of the radium salt from mixed barium and radium salts by fractional crystallization. Several flow sheets are given.

642   Meyer, H. "Determination of Radium by a Photographic Method." Brit. J. Radiology 15, 85-91 (1942).

Three exposures, 1 with the Ra prepn. to be measured and 2 with a standard prepn., are made on the same strip of film, being placed behind a Pb filter of 5 mm. thickness. The portions of the film not exposed at the time are shielded from radiation by Pb blocks of 20 cm. thickness. The standard exposures should be approx. 10% higher and 10% lower than that of the prepn. measured, to obtain a relationship between d. and exposure. The actual content in mg. of Ra element can be calcd. by a formula which is based on a linear relationship between the photographic darkening obtained and the exposure. Comparative results of the photographic and ionization methods are given, showing differences between +1.5% and −4.6% in the measured content.

643   Neitzel, E. "Ra Poisoning and its Prevention." Z. ges. Schiess-u. Sprengstoffw. 37, 74-5, 94-6, 114-16, 132-5, 155-6(1942).

Various well known examples of Ra poisoning are described. On account of its relation to Ca in the periodic table Ra can replace Ca wherever found in the animal organism. From its point of fixation in the body Ra exercises destructive effects upon the tissues, mainly by virtue of its disintegration products. In small doses the destructive effects are frequently not noticed until after long periods of time, sometimes as long as 10 years. The physiol. effects of the several disintegration products are described, as are the various means of measuring the radioactivity of samples and the several routes by which radium or its emanations may enter the human body. One of these is the breathing of Ra emanations. Charcoal, silica gel and Permutite were tried, without marked success, for absorbing these emanations. A detailed method is described for examn. of urine, blood, etc., for Ra emanations. Various diagnostic means and a quantitative method for estg. the amt. of Ra in the body and in cadavers are described. Various means of preventing Ra poisoning as prescribed by the safety precautions of the Association of Chemical Industry in Germany. A review of the literature is included.

644   Stevens, R. H. "Radium Poisoning." Radiology 39, 39-47(1942).

A 36-yr.-old man received during the period Jan. 21, 1925, to Nov. 24, 1930, a grand total of 440 γ of Ra chloride intravenously for Hodgkin's disease. Successive roentgenograms of the dorsal spine taken from Sept. 1936-Aug. 1941 showed destructive lesions at first attributed to Hodgkin's

1942

disease but later found to be due to Ra poisoning. Since Apr. 1937 the development of radionecrosis of the jaw was observed. This case constitutes one of the very few instances in which adequate data exist on the amt. of Ra injected, and on the amt. retained after a period of about 15 yrs. The fractional retention amounted to 11.4 γ of the total adm. of 440 γ or 2.5%.

1943

645   Ashkin, J., Bernstein, S., Feld, B. T., Kubitschek, H., and Szilard, L. Preliminary Comparison of Radon-Boron and Ra+Be Sources. University of Chicago. Jan. 19, 1943. (MDDC-1436;CP-412; A-452)

The intensity of a radon-boron neutron source was compared with a radium-beryllium neutron source (1 g. Ra + 3 g. Be). It was found that, reduced to equal gamma ray intensity, the neutron intensity of the two sources has a ratio of about 4 in favor of the radium-beryllium source if the intensity is measured by the (n,p) reaction in phosphorus, fast neutron fission or integration of the thermal neutron density in a water tank. It was found that the radium-beryllium source excites the 25 minute period of iodine two or three times as strongly as the radon-boron source, if the two sources are so normalized as to give equal fast fission counts in a uranium fission chamber. The impression is conveyed that radium-beryllium neutrons excite, in general, radiative capture more strongly than radon-boron sources.

646   Auergesellschaft A.-G. Radium Complexes. Belgian Pat. 448,736 (1943).

Ra compds. are made to react with solns. of alkylene-diaminotetraacetic acids (C_2 to C_6) or with halogenated and (or) oxygenated derivs. of these acids, or with alkali or NH_4 salts of these acids. The complexes formed are pptd.

647   Auergesellschaft A.-G. Separation of Barium from Mesothorium and Radium. Belgian Pat. 449,184 (1943).

A soln. of Ra and Ba salts is made alk. by addn. of $Ba(OH)_2$ and is then treated with Ba amalgam, with care to maintain a sufficient tension to avoid soln. of the Ba contained in the amalgam.

648   Auergesellschaft A.-G. (Asignee) Separation of Radium and Mesothorium from Barium. Belgian Pat. 449,199 (1943).

Solns. of Ba salts are electrolyzed with a Hg cathode at c.d. lower than 15 amp./$dm.^2$ The amalgam obtained is decomposed by means of dil. acids, water, or solns. or suspensions of Hg compds.

649   Cauchois, Y. "Experimental Determinations by (X-ray) Crystal Spectrography of the Inner Atoms which are Multiply Ionized in Inner Shells." Compt. rend. 216, 801-4(1943).

The positions of the X-ray satellite lines of the L series of heavy elements (with respect to the parent lines) are accounted for in terms of the multiple ionization of inner atomic shells. Energy values are tabulated for Pt, Au, Tl, Pb, Bi, Ra, and Th.

1943

650   Morse, K. M. and Kronenberg, M. H. "Ra Painting. Hazards and Precautions." Ind. Med. 12, 810-21 (1943).

651   Weiss, C. "The Question of the Radium Samples Established as Standards." Z. Physik 120, 652-72 (1943).

An intercomparison of Ra standards leads to the conclusion that the accuracy of these standards has been overestimated.

652   Weitzel, W. "Biology of the Living Cell. III. Influence of the Soil and Especially Its Radium Content on Plant Cells." Z. Volksernahr. 18, 193 (1943).

1944

653   Bretscher, E., Cook, G. B., and Martin, G. R. A Neutron Standard. Ministry of Supply, Great Britain. January 26, 1944. (BR-383)

A discussion of the preparation of $BaReF_4$ which lead to the subsequent preparation of $RaBeF_4$ is given. Information of the efficiency of a $RaBeF_4$ source, as well as the preparative method, is included.

654   Bretscher, E., French, A. P., Martin, G. R., and Poole, M. J. Determination of the Number of Neutrons Emitted by a Radium-Beryllium Source. Ministry of Supply, Great Britain. Decl. 1944. (BR-382)

A comparison was made between the activities induced under suitable conditions in manganese by a Ra-Be source and by a D-D source. The total neutron emission of the D-D source is derived from ionization chamber measurements. From these measurements the estimated strength of the Ra-Be source (0.5 g.) is 5.4×10^6 neutrons per sec.

655   Feld, B. T. Neutron Distribution in Paraffin. Argonne National Laboratory. February 24, 1944. (MDDC-1437)

Information on the relaxation length of Ra-Be, Ra-B (α,n) and Ra-Be, Ra-D (γ,n) source neutrons is given. The n-emission (pure γ) of Ra-Be is reported as 7×10^3 n/sec. for a 2 g. Ra source. (This document is a declassified portion of CP-1389).

656   Hemeon, W. C. L. "Ra Painting. Hazards and Precautions." Ind. Med. 13, 360-1(1944).

657   Hoecker, F. E. "The Rn/CO_2 Ratio as an Index to Excessive Ra Absorption." J. Ind. Hygiene Toxicol. 26, 281-8(1944).

Several methods of breath sampling are described and compared. The preferred method is the partial inflation of a 20-l. meterological balloon by the exhalation of occasional breaths during normal respiration. The detn. of the Rn/CO_2 ratio must be based on breath samples taken over as long a period of time as possible and under circumstances which avoid respiratory disturbances. Factors which disturb the Rn/CO_2 ratio in exhaled breath are discussed.

1944

658   Hoecker, Frank E. "The Significance of Absorbed Ra as Indicated by the Coefficient of Elimination." J. Ind. Hygiene Toxicol. 26, 289-95(1944).

The term "fixed" as applied to Ra in the body is ambiguous: this term should be defined in terms of the rate of elimination. The effect of internal Ra depends on quantity and time. Since the quantity and period of retention, and, therefore, the eventual danger depend on the rate of elimination, the detn. of the rate of elimination should furnish valuable data on the potential danger of internal Ra. 12 references.

659   Monk, A. T. and Allison, S. K. Computed Values of X-Ray Lines and Limits for the Trans-Uranic Elements. University of Chicago. Sept. 6, 1944. (AECD-2263)

Values of lines and limits also included for Ra.

660   Physikalisch-Technische Reichsanstalt. Catalog of Radium Content. Correspondence on the Analysis for Radium of Various Materials. ALSOS Mission. Dec. 1939-June 1944. 204 p. (PB-18576)

Binder containing reports on analysis of various radioactive materials, notes on delivery, sales, etc.

661   Rollier, M. A. "Extraction of the Active Deposit of Slow Evolution from Radium Sulfate." Rend. ist. super. sanita 7, 284-95 (1944).

Detailed description of the procedure whereby (1) a 700 mg. sample of $RaSO_4$ (0.5 g. Ra), in which the long-life disintegration products had accumulated for 5 years, was transformed into the chloride by fusion with an equimol. mixt. of Na_2CO_3 and K_2CO_3 and a subsequent treatment with HCl, (2) the active deposit of slow evolution was extd. by pptn. with H_2S, with Cu as carrier, and (3) an intense source of neutrons was prepd. by mixing the $RaCl_2$ intimately with finely powd. metallic Be.

662   Russell, H., Jr. The X-Ray Spectra of the Last-Row Elements. Los Alamos Scientific Laboratory. Sept. 22, 1944. (MDDC-406; LADC-216)

X-ray energy level diagrams tabulated for Ra, Th, and U. Proposed scheme for Pa also included.

663   Savel, P. "Determination of the Absolute Intensity of γ-Rays by the Ionization Method." Cahiers phys. 19, 39-50(1944).

The absolute intensities of the γ-rays emitted by a radioactive source may be detd. with an ionization chamber if its coeffs. of efficiency, K, are known as functions of the energy of the incident photons and the no. of disintegrations in the source. All that is then needed to det. the no. of photons emitted by the disintegration is a measurement of the ionization current. Expts. with the radiation from $RaBr_2$ through screens of air, Al, Si, A, Pb, etc., are described in illustration of the calibration of a particular ionization chamber, of which the construction is given.

664   Walen, R. J. "Semiautomatic Apparatus for the Extraction of Radon from Radium Solutions." Cahiers phys. 22, 29-32(1944).

1944

An app. of very simple construction for extn. of radon from Ra solns. is described. It employs a Hg diffusion pump to circulate the gas through the purification tubes, whence it is compressed into a storage bulb for filling ampoules. An initial filling of the app. up to 500 mm. Hg pressure requires 5 to 8 min.; and compression in the storage bulb 15 min. From 97 to 99% of the gas is recovered. Irradiation of the operator is reduced to a min. owing to the simplicity of operation of the app.

665   Wilkinson, D. H. Tests Concerning the Reproducibility of the RaBeF$_4$ Neutron Standard and its Calibration as a Source of Neutrons. Ministry of Supply, Great Britain. June 1, 1944. (BR-515)

On the assumption that a true compound containing radium and beryllium would constitute a more reproducible neutron standard than the mechanical mixtures of radium sulfate and beryllium powder used hitherto, three samples of RaBeF$_4$ were made. This standard was found to be reproducible to within the limits of experimental error (better than 0.5%). Its yield in neutrons/second/g. was found to be $(1.84 \pm 0.07) \times 10^6$. A simple technique for the calibration of Ra + Be neutron sources is described.

1945

666   Beckerley, J. G. Neutron Physics. A Revision of I. Halpern's Notes on E. Fermi's Lectures in 1945. Los Alamos Scientific Laboratory. 1945. (AECD-2664).

The first chapter of this report deals with neutron sources, the first seven pages having to do with self-contained sources. Ra-Be, Rn-Be, Po-Be, Na^{24}-Be, Mn^{56}-D$_2$O, Mn^{56}-Be, Ga^{72}-D$_2$O, Ga^{72}-Be, In^{116}-Be, Sb^{124}-Be, La^{140}-D$_2$O, La^{140}-Be, and Y-Be sources are treated as are several general rules for calculating n-emission.

667   Davis, F. J. "Report on Analysis by Radon Measurement and α-particle Counting". J. Assoc. Official Agr. Chem. 28, 682-4(1945).

A discussion of the electroscope, Geiger-Mueller counter, and radon methods for measuring Ra, and of the field of application of each. The radon method is suitable for samples of 10^{-8} to 10^{-14} g. of Ra. Any radon method of analysis requires considerable experience for operation, should be run continuously with frequent checks of background and standard samples, and requires at least one experienced person's full time to maintain equipment in operating conditions. The method requires an operator with an understanding of electronic circuits, such as high-gain amplifiers, or trigger circuits. In view of the fact that such equipment actually requires continuous operation to secure reliable results, in those situations where samples are measured at intervals of several weeks, the cost is prohibitive. Much better results, at lower cost, can be achieved by sending such samples to a lab. maintaining the required app.

668   Demers, P. Energy Distribution of Neutrons from Radium-Beryllium Mixed Source. National Research Council of Canada. 1945. (NRC-1597; MP-204)

357 proton recoils in a photographic emulsion from a Ra-Be mixed source were measured. The effect of the thick lead shielding used was estd. and corrected for by tests

1945

with Po-Be source. The energy distribution from the Ra-Be source is given. Test results are tabulated and illustrated by diagrams.

669   Deniges, G. "Ammoniacal Cyanuric Acid Reagent in the Microchemistry of Barium, Radium, Strontium, Thallium, Copper, Cadmium, and Zinc Ions." Bull. trav. soc. pharm. Bordeaux 83, 57-61(1945).

The stable reagent is prepd. by mixing 0.5 g. cyanuric acid, 10 cc. NH$_3$ soln., and 20 cc. distd. water, and shaking frequently for 5-10 min., warming slightly if necessary. After complete soln., add 20 cc. water, mix, and let cool. Mix 1 drop of reagent with a drop of the salt soln. (0.1-4.0%) on a glass slide, or add it to the dry residue from the salt soln., or to a very small particle (0.2-0.3 mg) of the solid compd. If crystals do not form readily, the mixt. should be stirred with a fine rod. Examine the crystals under a 130-50 magnification without covering. The crystal forms are described.

670   Drobkov, A. A. "Effect of Radioactive Elements upon Development of Root-Nodule Bacteria and upon the Assimilation by Them of the Molecular Nitrogen of the Atmosphere." Compt. rend. acad. sci. U.R.S.S. (2), 49, 224-6(1945).

In the absence of radioactive elements no nodules were formed on the roots of peas growing in water culture and no N was fixed even when the medium contained B and Mn and was inoculated with root-nodule bacteria. The addn. of Ra to the culture promoted the development of nodules and increased plant growth. The plants assimilated nearly twice as much N as a result of fixation as the Ra-free controls, even when normal doses of N were contained in the nutrient soln. The optimum dose of Ra was 10^{-10} g. per l. of nutrient but the plants could stand 10 and 100 times greater doses.

671   Gluckauf, E. Preliminary Report on the Number of Neutrons Emitted by a Beryllium-Radium Photo-Source. Ministry of Supply, Great Britain. Dec. 20, 1945. (BR-674)

The number of neutrons emitted by a standardized beryllium-radium photo-source has been determined by means of the helium method. The value found is considerably larger than would be expected from Feld and Fermi's neutron measurements in 1941: one gram of beryllium at a distance of 1 cm. from one gram of radium emits $53,000 \pm 800$ neutrons per second, as compared with Feld and Fermi's value of 30,000. The absolute neutron standard (in Montreal) of 600 mg. of radium in a standardized beryllium capsule was found to emit $3.03 \pm 0.09 \times 10^5$ neutrons per second.

672   Hönigschmid, O. "History and Preparation of the Primary Radium Standards." Anz. Akad. Wiss. Wien. Math.-naturw. Klasse 82, 30-4(1945).

The excellent agreement of calibrations based on the Paris and Vienna internatl. standards must be regarded as a fortunate coincidence as the two sets of masses used for weighing the RaCl$_2$ had not been compared with the standard kilogram.

673   Meyer, S. "Standard Radium Preparations." Anz. Akad. Wiss. Wien. Math.-naturw. Klasse 82, 25-30 (1945).

1945

Weiss' loss of faith in the reliability of the international standards is unwarranted. However, it is suggested to define future standards by the ionization they produce rather than by their wts.

674   Perry, W. E. "Wall- and Salt-Absorption Corrections in Radium-Content Measurements." Proc. Phys. Soc. (London) 57, 178-90(1945).

The measurement of Ra content by the γ-ray method involves correction for the absorption of the radiation in the wall of the container and in the radioactive material itself. Corrections are detd. for cylindrical containers made of Pt-Ir, Au, Au-Ag alloy and monel having wall thicknesses up to 2 mm. and external diams. up to 8 mm. Absorption measurements in powd. materials are described. Empirical formulas are derived; the results provide a basis for estg. absorption in Ra salts. Salt-absorption corrections are discussed. Exptl. absorption in powd. materials in detd. for: U_2O_8, $Th(SO_4)_2.9H_2$, $Bi_2(SO_4)_3$, PbO, $BaSO_4$, ZnS, S, MgO, and C. Mass absorption coeffs. are given for: $RaSO_4$, $RaBr_2$, $RaCl_2$, and $RaCO_3$. Application to radioactive luminous compds. is discussed, in particular those employing ZnS. Applications to Ra concentrates are discussed and to Ra and Be neutron sources.

675   Rollier, M. A. "Extraction of the Active Deposit of Slow Evolution from Radium Sulfate." Gazz. chim. ital. 75, 97-108(1945).

Detailed description of the procedure whereby (1) a 700-mg. sample of $RaSO_4$ (0.5 g. Ra), in which the long-life disintegration products had accumulated for 5 years, was transformed into the chloride by fusion with an equimol. mixt. of Na_2CO_3 and K_2CO_3 and subsequent treatment with HCl, (2) the active deposit of slow evolution was extd. by pptn. with H_2S, with Cu as carrier, and (3) an intense source of neutrons was prepd. by mixing the $RaCl_2$ intimately with finely powd. metallic Be.

676   Silberstein, H. E. Radium Poisoning. A Survey of the Literature Dealing with the Toxicity and Metabolism of Absorbed Radium. University of Rochester. May 26, 1945. 31 p. (AECD-2122)

Data on lethal dose, harmful amounts, and elimination studies for humans and animals. Tissue distribution studies. Extensive bibliography.

677   Singer, R., Airey, H. E., Grimmett, L. G., Leech, H. R., and Bennett, R. The Cerium Industry in German Territory Including Reports on Radium and Mesothorium. British Intelligence Objectives Sub-Committee. Trip No. 1226, September, 1945. (BIOS-FR-400; NP-39)

Information on the sepn. procedure for Ra from U plant sludges and from pitchblende at Treibacher Chemische Werke A.-G. Flow sheet, discussion of per cent recovery, cost of raw materials, sources, inventories, history of company, and customers. Brief letters and statements throughout report.

678   Walker, R. L. Absolute Calibration of a Ra-Be Neutron Source. Los Alamos Scientific Laboratory. Sept. 28, 1945. (MDDC-414;LA-400; LADC-155)

1945

The number of neutrons from a half-gram Ra-Be source (No. 44) has been measured by a method proposed by O. R. Frisch. The measurement consists in finding the volume integral of the neutron absorption rate in a boric acid solution. This adsorption rate is determined with the use of thin manganese and indium foils, standardized by means of a boron trifluoride counter. The ratio of the adsorption cross sections of boron and hydrogen for thermal neutrons enters as a correction term in the determination of the source strength, Q. This ratio was measured during the course of this experiment, and a value of 2270 obtained, as compared with 2380 found by H. Kubitschek at Chicago. The number of neutrons (Q) from source No. 44 was found to be 5.92×10^6 neutrons per second, with an estimated probable error of 5 per cent.

1946

679   Baranov, V. I. and Gorbushiwa, L. V. "Determination of Emanating Radioactive Elements by α-Rays." Zhur. Anal. Khim. 1, 129-34(1946).

The method comprises simultaneous detn. of true α-activity of a powd. sample and detn. of its emanation. This procedure permits detn. of not only the radioactivity of a sample but the approx. content of Ra, $AcX(Ra^{223})$ and ThX (Ra^{224}). The α-activity is measured 3 times; the tested powder is placed on a dish in a certain thickness. For the 2nd measurement more sample is added to double the thickness and for the 3rd thickness of the sample is tripled. If the sample contains Th it should be kept in the α-app. for 5 min. in order to attain Tn equil. The ionization current results are plotted by putting the no. of layers on the abscissa and the ionization current on the ordinate. The resulting straight line is horizontal if there is little emanation. If the sample emanates considerably, the line is inclined. The true value of α-activity for an infinitely thin layer is obtained by extrapolating the inclined line to an intersection with the ordinate. The effect of Tn is of ionization in the app. Ionization induced by An stabilizes within 15-20 sec. while that induced by Tn intensities for 5 min. An app. for detg. emanation is described. After Tn is detd. Ra is detd. in the usual way. The results are calcd. by the equation $Th/U = ThX/(Ra \times 3 \times 10^6)$.

680   Bernstein, S. Experimental Nuclear Physics. Neutron Standardization. Clinton Laboratories 1946(?). (M-3333)

The discussion includes data on the strength of Ra-Be n-sources and methods of determining source strength (absolute and relative). References are included.

681   Brues, A. M. et. al. Quarterly Report, August to October, 1946. Biology Division. Argonne National Laboratory. Nov. 27, 1946. (MDDC-684; CH-3711)

Report of experimental therapy on a man with a Ra content of 2 μg. Urine tests indicate some success. Discussion of changes in rat mean corpuscular hemoglobin after Ra ingestion.

682   Bystrov, E. N. "The Determination of AcX from its Emanation in the Presence of Considerable

Quantities of ThX.'' Compt. rend. acad. sci. U.R.S.S. (2), 52, 117-19(1946).
An air stream is passed at moderate velocity through the active sample of ThX (Ra²²⁴) and AcX (Ra²²³) and then through two ionization chambers of 1600 ml. each which differ in electrostatic capacity and sensitivity. The air speed is adjusted so that the α-activity caused by Tn will be the same in both ionization chambers. Since only the difference in ionization currents in the two chambers is detd., the app. is now insensitive to Tn. Any measured current is due to An, which decomp. completely in the first chamber. With an airstream velocity of 104 cc./sec., sensitivities of 6×10^{-16} g./division/min. for Th were attained.

683   Cantril, S. T. Biological Bases for Maximum Permissible Exposures. University of Chicago. July 18, 1946. (MDDC-601; CH-3571; PPr Vol. 20. Chap. 2).
Page 47 gives tolerance limits of 0.1 μg for Ra deposition within the human body.

684   Chang, W. Y. ''Low Energy Alpha-Particles from Radium.'' Phys. Rev. (2), 70, 632-9(1946).

685   DeMent, J. ''Fluorescence of Radium Burns.'' Science 103, 631(1946).

686   Evans, R. D. ''Evaluation of the Beta and Gamma Radiation Due to Extended Linear Sources of Radium.'' J. Ind. Hygiene 28, 243-56(1946).

687   Fineman, P., Weissbourd, B. B., Anderson, H. H., Sedlet, J., Ames, D. P., and Kohman, T. P. An Emanation Method for Radium Analysis. May 3, 1946. 28 p. (AECD-2620)
Apparatus and procedure for assay of radium in solution by an emanation method are described. The radon produced by the radium in a measured time is transferred with a stream of argon into an alpha ionization counting chamber. Interchangeability of emanating flasks and ionization chambers provides economy of time and apparatus and flexibility of operation. The use of a free-electron gas with a relatively low-frequency amplifier makes small amounts of electron-attaching gases and vapors in the chamber tolerable. Methods for calibration of the apparatus determination of the operating characteristics and corrections, and interpretation of results are described. Chemical procedures for obtaining solutions suitable for de-emanation from several types of radium containing materials are described. (See also item 731.)

688   Jacobson, L. O. and Simmons, E. L. Studies of the Metabolism and Toxic Action of Injected Radium. Part II. The Hematological Effects of Parenterally Administered Radium. A comparison of Plutonium and Radium Effects. (AECD-2372). University of Chicago. June, 1946.
The effects of the parenteral administration of radium chloride on the hematological constituents of the peripheral blood of rats, mice, and rabbits have been studied. Intraperitoneal and intravenous doses of from 0.005 to 0.94 μc./g. have been given to rats; intraperitoneal doses of from 0.000066 to 0.85 μc./g. to mice; and intraperitoneal or intracardial doses of from 0.0016 to 0.1 μc./g. to rabbits. There appeared to be no significant species difference in

the sensitivity of the hemopoietic systems of the rat and mouse to radium, but rabbits appeared to be slightly more resistant than the other two species. Also, CF-1 female mice appeared to be somewhat more resistant than ABC male mice, but whether this was a strain or sex difference has not been ascertained. In the rat, mouse, or rabbit no significant hematological alteration occurred after an injection (by any route) of 0.01 μc./g. or less of radium chloride. A dose of 0.02 μc./g. produced an anemia and sustained leucocyte reduction in rats. A dose of 0.03 μc./g. resulted in a severe recurrent anemia in ABC male mice (but not in CF-1 females), comparable changes in heterophil levels in both strains, and in an initial moderate reduction in lymphocytes in the ABC male mice. Doses as high as 0.1 μc./g., however, failed to produce an anemia in the rabbit, but did cause a mild, early, persistent reduction in leucocytes. A dose of 0.94 μc./g. in the rat resulted in an initial reduction in reticulocytes with subsequent overproduction and in a marked reduction in platelets with only moderate recovery. Morphological changes were seen in the nucleated cells of the peripheral blood after radium administration. These were largely comparable to those previously described in animals following the external application of radiations such as X ray, γ-rays, and fast neutrons, or internal radiation in animals following the parenteral administration of plutonium. As evidenced by an increased erythrocyte diameter and increased mean corpuscular hemoglobin, macrocytosis became apparent in rats, mice, and rabbits after the parenteral administration of doses of radium between 0.1 and 9.2 μc./g. 33 references.

689   Lindner, R. ''The Separation of Barium from Radium by Radiometric Adsorption Analysis.'' Naturwissenschaften 33, 119-21(1946).
Ra and Ba can readily be sepd. by chromatographic adsorption on Al_2O_3 using a radiometric detn. of activity. On elution of prepns. a few days old it is found that about 50% of the Rn remains on the alumina column. This is not due to ordinary adsorption of the Rn on the Al_2O_3 but is due to a ''rebound'' effect of the Rn formed from adsorbed Ra. A similar effect is found on adsorbing radioactive Pb(ThB); it can be desorbed only with great difficulty.

690   Mellor, J. W. A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Volume 4. Ra and Ac Families, Be, Mg, Zn, Cd, Hg. ''Chapter 6, Radium and Radioactivity.'' (p. 53-154). New York, Longmans Green. 1946.
This chapter has several sections on radium with extensive references at the end of each section.

691   Norris, W. P. and Evans, H. P. Studies of the Metabolism and Toxic Action of Injected Radium. University of Chicago. June 1946. (AECD-1965)
The most important period in defining the fate of radium in the animal body is that closely following administration, providing the material is readily available to the body fluids. This period is demonstrated in rats by the rapid disappearance of radium from the blood after intravenous injection and by the rapid uptake of radium from the peritoneal cavity as indicated by blood concentration curves following intraperitoneal administration. The excretion of intraperitoneally administered radium in rats and mice was very rapid and

1946

reached such a low value within 10 days that further excretion had a negligible function in determining the final retention. There exists a linear logarithmic dependence of per cent of injected dose excreted per day on time. More of the excreted radium was present in the feces than in the urine. The retention of radium, administered intraperitoneally to rats, mice, and rabbits, increased concomitantly with dose level. There exists a linear logarithmic dependence of per cent retention on dose level. Three possible explanations for this effect are offered. In rats and mice, intraperitoneally injected radium was found to cause calcification of some of the soft tissues. The effect was noted in high incidence in the aortas of both species. In rats, calcareous sites were also found in the pylorus, liver, peritoneal wall, the region of the upper mediastinum, and, occasionally, in the testicles. In mice, the only other observed site of calcification was on the trachea. Calcification of the soft tissues in rats was often accompanied by pathologic lesions throughout the abdomen and a high radium content in the viscera. The evaluation of the weight data in rats and mice, of the injected to control animals shows simple quantitative relations between weight effects and amounts administered or retained. On an equivalent roentgen basis, X-rays appear to be somewhat more effective in producing weight loss than radium. Evidence is presented to show that there exists a linear logarithmic dependence of mortality on retained microcuries of radium.

692   Nye, R. D. and Demorest, D. J.   Method of Extracting Uranium, Radium, and Vanadium from Their Ores.   U. S. Pat. 2,442,429 (1946).

A method of treating ores containing uranium, vanadium and radium is described. The ores are reduced mechanically to a relatively fine divided state, and the reduced ores are treated with a solution of an alkali carbonate. Heat and agitation are used to insure the complete dispersal of the radium and uranium. The treated ores and solutions are washed with upward flowing currents of water to separate the solution and suspended fines and floating slimes from a residue of coarse sand grains. The washed solution and its fines and slimes are treated with an acid sulfate until the solution is rendered acid. A solution of a metallic salt is then added to precipitate an insoluble sulfate form of the metallic component of the salt and to take suspended fines and slimes out of solution and thereby leave a clear supernatant solution and a sludge precipitate. The clear supernatant solution is separated from the precipitate mechanically. The supernatant solution is then treated with a caustic alkali base to precipitate concentrations of uranium, radium and vanadium compounds and to produce a basic alkali solution. The basic solution is reactivated for re-use in the washing of the treated ores. The sludge precipitate is combined with the residue of coarse sand grains for further concentrations of the remaining vanadium content by salt roasting.

693   Owen, E. R.   Production of Luminous Compounds at the Works of Auer Gesellschaft A.-G. (BIOS Target No. C21/371). British Intelligence Objectives Sub-Committee. 1946(?). (NP-46).

Discussion of prepn. of luminous paints primarily from ZnS and Ra. Information on source of Ra, amount on hand, sepn. method for Ra from U. Ra-Ba sepn. method used was fractional crystallization.

1946

694   Suruge, J. "The Radiations and Excitation Levels of a Few Radioactive Substances." J. phys. radium 7, 145-50(1946).

A review. The excitation levels and transitions and the intensity and energy of the different rays are given for the 3 natural radioactive families — radium, thorium, and actinium. 52 references.

695   Tompkins, P. C., Norris, W. P., Wish, L., Finkle, R. D., and Evans, H. P.   Methods for the Quantification of Radium.   University of Chicago. June 11, 1946. (MDDC-699; CH-3534)

Two methods have been developed for the estimation of radium in preparations containing insignificant amounts of Pb^{210}, Bi^{210} and Po. One method depends on the counting of alpha particles from radium after sufficient aeration of a radium solution to remove radon and permit the decay of the short-lived disintegration products. This method is applicable to pure solutions of radium and its decay products. A second method, which may be applied to biological materials, requires the coprecipitation of radium with barium sulfate after radon has been removed by heating the radium in solution. The radon and short-lived daughters reach equilibrium within the barium sulfate crystals. After a sufficient period of growth, beta rays from Pb^{214} and Bi^{214} are counted and compared with standard samples. Large errors may be encountered in the latter method, due to self-absorption, unless one measures and corrects for the solid content of the capsules. A modification of the coprecipitation procedure with barium sulfate permits the analysis of biological or other materials containing excessive amounts of inert ash. The beta method has been successfully applied in the analyses of urine, feces and whole carcasses of rabbits, rats and mice.

696   Vicklund, R. E. "Preventing the Fungus Fouling of Optical Instruments." Ind. Eng. Chem. 38, 774-9 (1946).

Brief information on prepn. of Ra containing metal foils for protection. Foils applied to Ag by powder metallurgical techniques.

697   Yalow, A. A. and Goldhaber, M. "Upper Limit of the Number of Low-energy Neutrons from a Ra-α-Be Source." Phys. Rev. (2), 69, 253(1946).

1947

698   Anderson, H. L. and Feld, B. T. "The Preparation of Pressed Radium Plus Beryllium Neutron Sources." Rev. Sci. Instruments 18, 186-8(1947).

A suspension of Be in an aq. soln. of $RaBr_2$ is evapd. to dryness. The solid is heated to about 200° to drive off all water, after which it is pressed in a hydraulic press to yield a compact, strong pellet of a density of 1.75 g./sq. cm. The pellet is enclosed in a brass container of 1/16 in. wall thickness. The yield of fast neutrons varies with the masses of the constituents as follows: yield = $1.7 \times 10^7 \, M_{Be}/(M_{Be} + M_{RaBr_2})$ n/sec./g. Ra.

699   Brar, S. S. and Moon, R. J.   Progress Report in Radiation Physics.   Aug. 1, 1947. (AECD-2024-A)

1947

Progress is reported on the following problems: surface dosage measurement of plutonium (Pu^{239}); absolute activities of P^{32}, Sr^{89}, Sr^{90} and C^{14}; and determination of radium in the body.

700   Brues, A. M., Lisco, H., and Finkel, M. "Carcinogenic Action of Some Substances which may be a Problem in Certain Future Industries." Radiology 49, 361-3(1947). (MDDC-145)
Brief information on deposition sites and tumor formation caused by Ra injections in mice, rats and rabbits.

701   Feld, B. T. and Fermi, E. Neutrons Emitted by a Radium-Beryllium Photo-source. University of Chicago. Decl. Nov. 5, 1947. (MDDC-1438; C-89)
In this report an account is given of experiments performed at Columbia University in November 1941 on certain properties of the photo-neutrons emitted by beryllium irradiated with gamma rays from radium. The slowing down of the photo-neutrons in graphite was investigated by taking activity measurements of indium detectors inside a graphite pile in which the source was included and the slowing down properties were expressed in terms of a two-range formula. Also the number of neutrons emitted by the photo-source was measured by comparison with a Ra-Be source of known intensity.

702   Hsin, S. C. "Relation Between the Temperature of Treatment and the Intensity of Luminescence of Phosphors." Chinese J. Phys. 7, 54-5(1947).
The exptl. data of Kabakjian have been analyzed to det. whether the lattice defects are directly responsible for the phenomenon of luminescence. Plotting the intensity of luminescence vs. temp. shows that the dependence is of the exponential type. The calcd. values of the disorder energies are: $RaBr_2$, 10.7 ev.; $RaSO_4$, 2.5 ev.; $BaBr_2$, 4.7 ev.; and two values for $BaCl_2$, 1.5 ev., and 0.49 ev. The nearly const. value of the intensity of luminescence of anhyd. $RaBr_2$ at about 450° and below is attributed to the relatively high value of its disorder energy. In the case of $BaCl_2$ it is suggested that either there are two different disorder energies for the two Cl ions attached to the same Ba ion, or that one of the Cl ions is evaporated away while the other goes into interstitial positions.

703   Kohman, T. P., Ames, D. P., and Sedlet, J. The Specific Activity of Radium. Argonne National Laboratory. March 25, 1947. 21p. (MDDC-852)
The specific alpha activity of radium has been determined by counting the alpha particles emitted by aliquots of weighed radium chloride samples in a high-speed parallel-plate ionization chamber of known counting yield. A special method was devised to correct for the alpha activity of radon and its daughters, which has heretofore been the chief deterrent to the use of this direct method for radium. The measurements yielded a specific counting rate of $1.1148 \pm 0.0059 \times 10^{12}$ counts per minute per gram of radium. Taking the counting yield as 0.515 ± 0.003, this corresponds to a specific activity of $3.608 \pm 0.028 \times 10$ alpha disintegrations per second per gram and to a half-life of 1622 ± 13 years. (See also item 735.)

704   Rush, J. H. "Range of Ra-α-Be Neutrons in Water." Phys. Rev. (2), 73, 271-3(1948). (MDDC-1050)

1947

Radial distribution of Ra-α-Be neutrons about an approximate point source in water were determined by means of In foil activations. Values for migration area derived from the data are: for all activating neutrons, 54.6 cm².; for In resonance neutrons, 45.4 cm².

705   Seidl, F. G. P. and Harris, S. P. "Calibration of a Radium-Beryllium Neutron Source by the Boron (n,α) Lithium Reaction." Rev. Sci. Instruments 18, 897-9(1947). (MDDC-1193; ANL-HDY-210)
The abs. evaluation of a neutron flux is measured by the He produced by the reaction: $Be^{10} + n^1 \rightarrow He^4 + Li^7$ if the fraction of the neutrons captured by B is known. However, difficulties arise in measuring $\sim 10^{-6}$ cc. of He if the gas is sepd. from large vols. of other substances. An indirect procedure was used: the neutrons were captured in Mn as well as B mixed in an aq. soln. to establish the ratio of Mn activity to B-Be production. A large vol. of the soln. was exposed to the Ra-Be neutron source, the γ-activation was measured and from this amount of He produced during the source irradiation could be calcd. A brief description of the lab. procedure is presented. Calcn. of the no. of neutrons emitted per sec. from a Ra-Be source was made from the equation: $Q = V_{He} - (N_{AM}I_8\Sigma_t)/ftMi_p\Sigma_B)$, where V_{He} is the vol. of He in cc. at S.T.P. produced by the pile irradiation, N_A is a const. depending on units, f is the fraction of source neutrons absorbed in the soln., t is the length of time of irradiation, both of the source and in the pile, m/M is the fraction by wt. of the pile-irradiated soln. that, when thoroughly mixed with similar inactive soln., yields a measured γ-activity proportional to I_p, I_8 is proportional to the γ-activity of the source-irradiated soln., and Σ_t/Σ_B denotes the ratio of total neutron capture to capture by the B. The Ra-Be source designated by the lab. as No. 38 contains 504 millicuries as Ra based on $RaBr_2$; the mass of the Be is 300 mg.; the no. of neutrons emitted per sec. $Q = (5.5 \pm 0.4) \times 10^6$.

706   Shulyatikov, B. "The Distribution of Electrolytes Between a Solid and a Liquid Phase." J. Phys. Chem. (U.S.S.R.) 21, 975-82(1947).
The distribution of a salt (e.g., $RaSO_4$) present in minute concns. between a solid (e.g., $BaSO_4$) and its soln. is detd. thermodynamically. The relation among the equations of Ratner, Imre, and Paneth and Thimann is shown. The true distribution const. depends on the heats of soln., the activity coeffs., and the works of transfer, e.g., of $RaSO_4$ from pure $RaSO_4$ into a solid soln. in $BaSO_4$.

707   Studier, M. H. and Hyde, E. K. A New Radioactive Series—The Protoclinium Series. Oct. 6, 1947. (MDDC-1567)
Section 4.6 contains information on the method of measurement of Ra^{222} half-life which is reported to be a 38 sec. α emitter.

708   Victor, C. P. "Analysis of the Quantities of Radium and of Radiothorium Present in a Source of Mesothorium Without Chemical Treatment." J. Phys. Radium 8, 298-301(1947).
The large difference in the yield of neutrons when Be and D are bombarded with the γ-rays of Ra compared to that

1947

obtained with RdTh is used as the basis of the method. The photo-neutrons obtained from Be and D with an unknown mixt. are compared with those obtained from known standards. The no. of neutrons was detd. by retarding with the aid of paraffin, activating Ag, and counting the β-rays thus evolved. By measuring the total emission of the original sample, the amts. of Ra, MsTh, and RdTh can be obtained.

709   Weikel, J. and Lorenz, E. Excretion of Radium from the Mouse. Argonne National Laboratory. Oct. 1947. (MDDC-1587)

Excretion of radium following intraperitoneal injection was studied in three groups of strain C3H mice. Two groups were given British Anti-Lewisite as a possible means of increasing the elimination rate. In addition the radium content of a few organs of selected mice of the first group was obtained. An average 19% of the injected radium remained in the mouse at death. The average elimination rate in the chronic stage agrees well with that found by other observers. The radium was found to concentrate in the bone immediately. It was not eliminated from the bone rapidly as it was from most of the soft tissues, notably the spleen. Moreover, the lungs contained very little radium, whereas in the experiments of Evans et al., the lungs were the richest soft tissue. BAL had no effect on the rate of elimination. 10 references appended.

1948

710   Anderson, H. L. Neutrons from Alpha Emitters. University of Chicago. December 1948. (NP-851)

This report contains a discussion of many neutrons sources based on Po as an α emitter. Yields, energies, and measurement methods are discussed. The yield of neutrons from many substances with α's of several energies is tabulated. The preparation and properties of Po-B and Ra-Be sources are discussed at length.

711   Anderson, H. L. to United States Atomic Energy Commission. Compact Neutron Source. 1948. (U. S. Pat. 2,440,999 (Reviewed in Chemistry 21, 43(1948)).

Finely powdered beryllium metal is mixed with a solution of radium bromide which has been freed of radioactive decomposition products by boiling. The mixture is formed into a cylindrical pellet, slightly more than three-tenths inch in both height and diameter, in a press capable of applying pressure above ten tons per square inch. This pellet, tightly sealed in a brass cylinder, becomes the source of the desired neutrons.

712   Barclay, A. E. (ch.) Recommendations of the British X-Ray and Radium Protection Committee. Seventh Revised Report (October 1948). (NP-922)

Information on protection of personnel against Ra hazards.

713   Brues, A. M. and Lisco, H. (eds.) Biology and Medical Division Quarterly Report May 1948 to August 1948. Argonne National Laboratory. Aug. 1, 1948. (ANL-4205) p. 10-23. "Effects of Radium on Alkaline Phosphatase Activity of Tissues." by S. H. Cohn and W. P. Norris.

1948

Studies made in rats injected with $RaCl_2$.. Results show effects to be almost entirely on the phosphatase-forming elements of the bone.

714   Brues, A. M. and Lisco, H. (eds.) Biological and Medical Divisions Quarterly Report August 1948 to November 1948. Argonne National Laboratory. Nov. 1, 1948. (ANL-4227) p. 188-9. "Late Effects of Radium and Plutonium on Bone." by M. A. Bloom and W. Bloom.

Investigations on CF-1 mice. Studies of femurs and vertebrae of 100 animals given single dose of Ra or Pu two months prior to sacrifice. Ra dosed mice showed atypical fibrous bone. Cortical bone of the shaft contained many empty lacunae.

715   Gamertsfelder, G. R. and Goldhaber, M. "A Reproducible Neutron Standard." Phys. Rev. (2), 69, 368-9 (1948).

The source consists of 100 mg. Ra, enclosed in glass, surrounded by a monel tube 1 cm. long, 4.85 mm. outside diam., with 1 mm. walls. With this source a solid cylindrical block of Be 1.5×1.5 in. is irradiated; the axis of the Ra source is 4 cm. above, and parallel to, the upper face of the Be cylinder. This reproducible neutron standard emits 62 ± 7 n/mC. Ra/sec. When the distance between the axis of the Ra source and the face of the Be cylinder is varied, the distances and relative neutron intensities are: 1 cm., 2.35; 3 cm., 1.52; 4 cm., 1.99; 5 cm., 0.716; 6 cm., 0.567. A Ra-α-Be source yields 6800 n/mC. Ra/sec.

716   Ghiorso, A., Hollander, J. M., and Perlman, I. The Alpha-Particle Energy of Ac^{227}. University of California. July 19, 1948. (AECD-2232; UCRL-151)

Pile irradiation of Ra^{226} yields Ac^{227}. The α energy for Ra^{226} is referred to as 4.791 mev.

717   Hagemann, F. Isolation of Actinium(Ac^{227}). Argonne National Laboratory. Feb. 1948. (AECD-1933)

Discussion indicates that Ac^{227} is prepared from Ra^{226} by the reaction. $Ra^{226}(n,\gamma) \, Ra^{227} \xrightarrow[\text{(short)}]{\beta^-} Ac^{227}$ in a quantity indicating a n-capture cross-section of 18 to 20×10^{-24} cm.^{2} for Ra^{226}. (Upon repetition of experiment, value of 14×10^{-24} cm.^{2} was obtained.) The results for Ra^{226} based on work of Peterson.

718   Houtermans, F. G. and Teucher, M. "The Number of Fast Neutrons Emitted from a (Ra-α + Be) Source." Z. Physik 124, 700-4 (1948).

The number of neutrons above the fission threshold energy of U^{238} emitted by a (Ra-α + Be) source was found to be 3800 ± 1000/sec./mC., i.e., about 50% of all neutrons emitted. The experiments were made using an ionization chamber, lined with U_3O_8, which was connected to a linear amplifier having a resolving time of approximately 1μ sec.

719   Kapustinskii, A. F. "Thermochemistry and Atomic Structure. I. The Role of Thermochemical Logarithmicity and the Heats of Formation of Halides." Izvest. Akad. Nauk S.S.S.R. Otdel. Khim. Nauk 568-80 (1948).

1948

The heat of formation - ΔH of a compd. from the elements in the standard states, divided by the valency W (standard-state heat of formation per g. - equiv.) is proportional to the logarithm of the product of the at. nos. Z of the elements. It was found that, from linear plots of $\Delta H/W$ against log Z, interpolation or extrapolation of unknown - ΔH values were permissible. For series $RaCl_2$ and $HfCl_2$ the value - $\Delta H(RaCl_2)$ = 230 k cal./mole is predicted.

720   Kapustinskii, A. F. "Thermochemistry and Atomic Structure. II. The Rule of Thermochemical Logarithmicity and the Heats of Formation of Oxides and Hydrides." Izvest. Akad. Nauk S.S.S.R., Otdel. Khim. Nauk 1948, 581-9.

Continuation of study reported in preceding article - ΔH (RaO_2) = 150 k cal./mole is predicted.

721   Lecoin, M., Perey, M., and Teillac, J. β-Radiation of Mesothorium 2 and Mesothorium 1." Compt. rend. 227, 121-3(1948).

By use of a Wilson chamber with ordinary pressure or under reduced pressure, a study of radiation showed with the normal-pressure type that some β-rays (less than 3 disintegrations) are attributable to the disintegration of $MsTh_1$ (Ra^{228}), the energy of these rays being less than 15 kev. With reduced-pressure type the number of electrons attributable to $MsTh_1$ is 15% at 20 cm. of initial pressure and 16% at 10 cm. Experimental conditions show β-rays of energy as low as 1.5 kev. which have a course of 5 mm. at initial pressure of 10 cm.

722   Neidrach, L. W., Mitchell, A. M., and Rodden, C. J. Analytical Chemistry of the Manhatten Project. Chapter XXVI. Beryllium, Magnesium, Calcium, Strontium, Barium, and Radium. 1948(?). (AECD-2159)

Detailed description of the Rn measurement method with Ra in soln. Methods for dissolving Ra bearing ores, boil out of Rn, method of detn. of Rn, apparatus diagram, etc. (pages 24 to 28).

723   Nuclear Engineering Course 1947-1948. Assignment IV. Knolls Atomic Power Laboratory. (KAPL-PC-167)

Method for calculating activity of Ra salts and Ra salts in equilibrium with disintegration products.

724   Quimby, E. H. "Fifty Years of Radium." Am. J. Roentgenol. Radium Therapy 60, 723-30(1948).
Histological survey.

725   Reid, A. F. "Multistage Ion-Exchange System for the Fractionation of Solutes." Ind. Eng. Chem. 40, 76-8(1948).

The utilization of selective adsorption capacities of ion-exchange substances in a reflux multistage system is described. Selective absorption of a portion of the ions in a through-going soln. by an exchange cell and regeneration by the acidified output soln. of a previous cell comprise a repetitive cycle for the continuous sepn. of the fractions. Application of the method to a pilot plant for the concn. of Ra-Ba mixts. is discussed.

1948

726   Tompkins, E. R. "Separation of Radium from Barium by the Use of an Ion-Exchange Column Procedure." J. Am. Chem. Soc. 70, 3520-1(1948). (AECD-1998; MonC-417)

By the use of a high-capacity cation-exchange resin (Dowex 50), the Ra in a soln. contg. 20 γ Ra, 20 mg. Ba, and 20 mg. Sr, including Ba and Sr tracers, is essentially completely sepd. from Ba and Sr. The compn. of each fraction of the effluent was detd. from the α, β, and γ-ray activity and Al absorption and decay curves of radioactivity. Exptl. conditions and a table and graph showing the compn. of the eluate fractions are given. The method is suggested both for com. sepn. and quant. analysis of Ra.

1949

727   Alder, F. and Huber, P. "A Method for the Determination of the Absolute Intensity of a Ra-Be Source of Neutrons." Helv. Phys. Acta 22, 268-71(1949).

A method is described for the determination of the absolute intensity of a neutron source, being a modification of the procedure of Gamertsfelder and Goldhaber (Phys. Rev. 69, 368 (1946)). A solution of $MnSO_4$, used as a moderator, fills a spheric container in the center of which is placed the Ra-Be source; the activity of the stirred solution gives the relative number of neutrons absorbed; by taking this measurement at two different concentrations of the solution, the absolute number of neutrons is obtained. It was found that a 1 mc. Ra-Be source emits 6.300 ± 7.5% neutrons/sec., a result which agrees with those obtained by some of the other methods.

728   Ames, D. P., Sedlet, J., Anderson, H. H., and Kohman, T. P. "Rapid Radiometric Assay for Radium, and Application to Uranium Ore Process Solutions." (AECD-2696) in The Transuranium Elements. Research Papers, pt. II. ed. by G. T. Seaborg, J. J. Katz, and W. M. Manning. N. Y. McGraw-Hill. 1949. p. 1700-16.

A rapid method of assay for radium in solution based on the precipitation of radium with barium as carrier and counting of its α particles, is described. In sulfate-free solutions $(Ba,Ra)Cl_2$ is precipitated with concentrated hydrochloric acid and ether. In sulfate-containing solutions $(Pb, Ra)SO_4$ is first precipitated, followed by a $(Ba, Ra)Cl_2$ precipitation. The chloride is converted to the sulfate on a Pyrex disc for counting α particles in a parallel-plate ionization chamber. The method is general for all α-emitting radium isotopes, sensitive to 10^{-12} g. Ra^{226}, and accurate to 3-10%. It separates radium from all other α-emitting substances accompanying it in nature. Applications to uranium ore process solutions are described. The method is found suitable for certain control problems in which knowledge of approximate radium concentrations is required in 30-60 min. In this application the sensitivity is limited by interfering activities to 10^{-10} g. Ra/ml.

729   Bloom, M. A. and Bloom, W. "Late Effects of Radium and Plutonium on Bone." Arch. Path. 47, 494-511(1949). (AECD-2053; ANL-HDY-496)

Radium injected into mice intraperitoneally at dose levels of 0.3 and 0.03 μc/g, and plutonium, 0.03 and 0.003 μc/g

1949

given intravenously, produce an overgrowth of bone in the femurs and vertebrae. In the femur this overgrowth begins in the distal metaphysis and is more extensive there than in epiphysis or shaft. This atypical bone, surrounded by gelatinous marrow, fills the metaphysis and encroaches on the marrow of the shaft, which is also invaded by new bone from the endosteum, and, in the extreme cases, the two processes combine in some areas to obliterate the marrow. The bone formed after radium treatment is atypical and fibrous, and much of it becomes devitalized. The cortical bone of the shaft also contains many empty lacunae. After plutonium treatment the newest bone is also fibrous, but the greatly thickened trabeculae of spongy bone becomes progressively more compact, although the extremely irregular arrangement of lamallae and osteocytes distinguishes them from normal bone. Empty lacunae are fewer than after radium. Early changes of an atypical proliferative nature were seen in a 3-month specimen after radium and in a 7-month specimen after plutonium, and may represent early sarcoma or a predisposing state. Resorption of the necrotic bone does not seem to have occurred. Infraction of the marrow was seen in two of the radium- and one of the plutonium-injected animals. The changes in the vertebrae are essentially like those in the femurs.

730   Bretscher, E., Cook, G. B., Martin, G. R., and Wilkinson, D. H. "Preparation and Properties of a Reproducible Neutron Standard." Proc. Roy. Soc. (London) 196A, 436-43(1949).

Radium beryllium fluoride ($RaBeF_4$) is proposed as a new form of Ra-α-Be neutron source, for adoption as a standard. Three such sources have been prepared and calibrated; they give a neutron yield which is proportional to the Ra content to within $1/2\%$. Details were given of the techniques used in the preparation and standardization of these sources; probable errors in the calibration are discussed. 10 references.

731   Fineman, P., Weissbourd, B. B., Anderson, H. H., Sedlet, J., Ames, D. P., and Kohman, T. P. "An Emanation Method for Radium Analysis." (AECD-2620; MUC-GTS-2320) in The Transuranium Elements. Research Papers, pt. II. ed. by G. T. Seaborg, J. J. Katz, and W. M. Manning. N. Y., McGraw-Hill. 1949. p.1206-25.

This reference is identical to item 687.

732   Khlopin, V. G. and Klokman, V. R. "Distribution of Radium Between the Fused Mass of Isomorphic Salts and Their Crystals." Izvest. Akad. Nauk, S.S.S.R., Otdel. Khim. Nauk. 254-62(1949).

The distribution of radium was studied between the fused mass of the following isomorphic salts and their crystals: barium nitrate, lead nitrate, lead sulfate, and strontium nitrate. It was found that in all cases the distribution follows the Berthelot-Nernst law. The distribution coefficient in these systems is less than one, or equal to one, which shows that, at temperatures of the order of 300-400°, the fused mass is enriched in radium, or, in other cases, the microcomponent is distributed about equally between the fused substance and the crystals.

1949

733   Khlopin, V. G. and Merkulova, M. S. "Adsorption of Radium on Lead Sulfate in the Presence of Substances which Lower the Surface Tension." Izvest. Akad. Nauk S.S.S.R. Otdel. Khim. Nauk, S.S.S.R. 460-72(1949).

It is shown that the kinetic ion exchange between a solution and the surface of a crystalline phase is always hampered by substances that lower the surface tension. This is seen in the slowing down of the process, the time required for the establishment of the equilibrium being longer in all cases when substances lowering the surface tension are present, than it is in their absence. If such a substance forms a difficulty-soluble compound with the crystal ions, its presence not only slows down, but can actually suppress the kinetic ion exchange reaction; this is true in cases involving the exchange of ions of the adsorber, as well as in those of adsorption of isomorphic ions, or of co-crystallization of isomorphic substances. Effects of this kind are produced by salts of humic acids; therefore, the current method of quantitative determination of radium by co-precipitation with barium sulfate in a water solution rich in humic substances, can lead to serious errors if no special precautions are taken. In an experimental study on the adsorption of radium on lead sulfate, it is shown that correct results are obtained if both the absorbing suspension and the saturated solution are prepared in the presence of the substances which should be present in the subsequent process of primary ion adsorption.

734   Klokman, V. R. and Khlopin, V. G. "Distribution of Radium Between a Melt and Crystals of a Non-isomorphous Salt." Doklady Akad. Nauk. S.S.S.R. 65, 33-6(1949).

K_2SO_4, crystg. from a melt of 0.5 g. K_2SO_4 + 7 g. KNO_3, occludes Ra (5×10^{-8} to 9×10^{-6} g./g. K_2SO_4) in conformity with the law of Berthelot-Nernst, the crystn. coeff. D = x $(100 - y)/y(100 - x)$(where x = % Ra occluded in the crystals, y = % of K_2SO_4 crystd.) remaining const. = 0.065. Presence of small amts. of Al^{+++} (in the form of dehydrated $KAl(SO_4)_2$) lowers D considerably; thus 0.3 mg. Al suppressed the occlusion of Ra altogether. Consequently, the occlusion of Ra is of the same type as that found in crystn. from soln.

735   Kohman, T. P., Ames, D. P., and Sedlet, J. "The Specific Activity of Radium." (MDDC-852) in The Transuranium Elements. Research Papers, pt. II. ed. by G. T. Seaborg, J. J. Katz, and W. M. Manning. N.Y., McGraw-Hill. 1949. p.1675-99.

This reference is identical to item 703.

736   Kremenak, B. "The Question of the Accuracy of Standard Radium Preparations." Acta Phys. Austriaca 2, 299-311(1949).

In 1947 the activities of the primary Vienna standards prepd. in 1911 and 1934 agree well with calcd. values. Secondary standards prepd. in 1911 show a deviation of less than 0.2% when compared by use of Curie plate condenser, Wulf γ-ray electrometer, and Wulf radiation chamber. The objections of Weiss against the reliability of standard Ra prepns. are not valid.

737   Lecoin, M., Perey, M., and Teillac, J. "The β-
         Radiation of Mesothorium 1 and Mesothorium 2."
         J. phys. radium (8), 10, 33-41(1949).

The actual data concerning β-radiation of $MsTh_1$ (Ra^{228}),
although somewhat contradictory and incomplete, have been
studied and obtained by means of a Wilson cloud chamber.
The selection of initial products of $MsTh_1$ and the procedures
of chem. purification were taken into account in the disposition
of $MsTh_1$ contg., in nos. of disintegrations, 0.8 per 100 of Ra
and less than 0.5 per 100 of ThX (Ra^{224}). The expts. con-
sidered were of some duration. It is first necessary to det.
the proper radiation of the $MsTh_2$. These studies have been
performed by use of the Wilson chamber at pressures vary-
ing between ordinary pressures and 10 cm. of Hg. Thus it is
possible to det. that: (1) the β-spectra of $MsTh_2$ shows 2
components with intensities gradually becoming equal, these
two components blending at approximately 60 kev. The total
no. of β-rays for disintegration of $MsTh_2$ is about two. There
is no simultaneity in the emission of the radiation belonging
to the two components. (2) The disintegration of $MsTh_1$ ac-
companies the emission of a band of β-rays of weak intensity,
only 15 electrons per 100 disintegrations. The energy of
these radiations varies between 1.5 and 18 kev. The spectral
distribution of these radiations appear to indicate the pres-
ence of two or three lines of 3,7, and perhaps 12 kev., which
implies the secondary origin of these lines.

738   McCallum, K. J. "Preparation and Use of Neutron
         Sources." Nucleonics 5, 11-21(1949).

The most common α-neutron source is Ra-Be. Also used
are Po sources, which have the advantage that they emit
only weak γ-radiation. Properties of photo-neutron sources
are tabulated. In using neutron sources containing Ra, pro-
tection against γ-radiation is more important than against
neutrons.

739   Peterson, S. and Ghiorso, A. "Thermal Neutron
         Fission Properties of Ac^{227}, and Ra^{228}." (AECD-
         2514; ANL-JJK-14B-156) in The Transuranium
         Elements. Research Papers, pt. II. ed. by G. T.
         Seaborg, J. J. Katz, and W. M. Manning. N. Y.,
         McGraw-Hill. 1949. p. 1381-4.

A preliminary study has been made of the thermal neutron
fission properties of several naturally occurring radioiso-
topes. Limits on thermal fission cross-sections have been
determined as follows: $Ac^{227} < 2 \times 10^{-24}$; $Ra^{223} < 100 \times 10^{-24}$
cm^2; $Ra^{228} < 2 \times 10^{-24}$ cm^2. Fission measurements were
made in the thermal column of the Argonne heavy-water
pile. The procedure for the separation and purification of
the several isotopes measured are briefly described.

740   Rosenblum, S., Valadares, M., and Perey, M. "Spec-
         trum of α Radiation Emitted by RaTh + ThX." Compt.
         rend. 228, 385-7(1949).

While studying the magnetic α-spectrum of RaTh, the
authors found two lines, whose intensities were 1% and 0.4%
of that of the ray of RaTh; these lines belong to ThX formed
during the exposure. The difference $\alpha_0 - \alpha_1$ThX is 245 kev;
von Bayer, Hahn, and Meitner (Physik. Z. 16, 6(1915)) men-
tion a γ-radiation of 250 kev. which is attributed by them to

ThX. The present authors determined $H\rho\alpha_0$RaTh/$H\rho\alpha_1$RaTh =
1.0079 and $H\rho\alpha_0$ThX/$H\rho\alpha_0$RaTh = 1.0236; since the energy of
α_0ThX is 5681 kev. (Briggs, Proc. Roy. Soc. (London) 139,
638(1933)), the values 5423 and 5338 kev. are obtained for
the energies of α_0RaTh, respectively; the difference, cor-
rected for the recoil, is 86.7 kev. The intensity of the line
α_1 is 39 ± 1% of that of α_0.

741   Rosenblum, S., Valadares, M. Perey, M., and Vial
         J. "Fine Structure of the Magnetic Alpha Spectrum
         of Thorium X." Compt. rend. 229, 1009-11(1949).

In a previous article on the spectrum of the radiation
emitted $Th^{228} + Ra^{224}$ (ThX) (Rosenblum et al., Compt. rend.
228, 385(1949)), the existence of a fine structure in the mag-
netic alpha spectrum of ThX was indicated. The previous
experiments have been repeated using almost pure samples
of ThX, separated from a Th^{228} source by a method described
in detail. A plot of the spectrum is given and it is seen to
consist of three components. The energy of one of the com-
ponents has already been determined (Proc. Roy. Soc. (Lon-
don) 238, 638(1933)). The other energies may be calculated
from this value. It is found that the intensities of the differ-
ent components are in good agreement with the theory of
Gamow.

742   Rosenquist, I. T. "Some Investigations in the
         Crystal Chemistry of Silicates." I. Diffusion of
         Pb and Ra in Feldspars." Acta Chem. Scand. 3,
         569-83(1949).

A theoretical treatment of the diffusion of ions in crystal-
line silicates is followed by reports of studies on the diffu-
sion coefficients of Pb^{++} and Ra^{++} in potash (microcline)
and sodafeldspars (albite) at different temperatures. The
use of radioactive tracers makes it possible to study dif-
fusion processes with much higher accuracy than by the
earlier methods. RaD(Pb^{210}) and $RaBr_2$ were used in the
studies; the latter as the source of Ra^{++}. It is shown that
the diffusibility depends on the crystallographic directions
and that Ra^{++} diffuses more slowly in all directions in albite
than in microcline pertite at the temperatures investigated.
From measurement of the distribution coefficient resulting
from diffusion the following results were obtained: The
potash feldspar distribution coefficients for Ra and RaD,
respectively, were 1.045 and 1.87; the sodium feldspar dis-
tribution coefficients for Ra and RaD, respectively, were
1.3 and 1.15. It was also shown that diffusion anisotropy
seems to increase with increasing temperature.

743   Teucher, M. "On the Primary Spectrum of Fast
         Neutrons from Ra-α + Be Source, and on Their In-
         elastic Collisions in Be, Bi, and Pb." Z. Physik
         126, 410-21(1949).

The inelastic scattering of fast neutrons in Be, Bi, and Pb
was studied with the aid of a Ra-α + Be source occupying the
center of a sphere made of the absorbing material under in-
vestigation and placed inside an ionization chamber; the
latter's walls were coated with uranium or thorium. The
energy spectrum of the neutrons was determined by using
the tracks of recoil protons in the photographic emulsion.

1950

744   Jesse, W. P. Forstat, H., and Sadauskis, J. "The Ionization in Argon and in Air by Single Alpha-Particles as a Function of Their Energy." Phys. Rev. (2), 77, 782-6(1950).

An extended series of measurements has been made to determine the possible variation in W, the energy to make an ion pair in pure argon, with the energy of the ionizing α-particle. The ionization in argon relative to the ionization produced by a comparison polonium α has been measured for the α emitters Ra^{224}, Bi^{212}, Po^{216}, Po^{214}, and Po^{212}. For α-particles in the energy region from 5 to 9 mev., no deviation of W from the average W for the polonium α could

1950

be found amounting to as much as 0.5%. This is in marked contrast to the α ionization in air from the work of Stetter.

745   "Permanent Standard of Neutron Intensity Necessitated by Increasing Importance of Neutrons as Bombarding Agents in Physical and Biological Research." Chem. Eng. News 28, 180(1950).

The n-standards, prepared by National Bureau of Standards, are Pt-Ir coated $RaBr_2$ capsules in the center of Be metal spheres. Neutron emission is said to be 1.1×10^6 n/sec. Calibration, decay, and duplicate standard problems are briefly discussed.

AUTHOR INDEX

DOCUMENT NUMBER INDEX

SUBJECT INDEX

PATENT NUMBER INDEX